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The Nuts and Bolts of Baseline Setting:

Why, What and How?

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The Nuts and Bolts of Baseline Setting: Why, What, and How?

This document provides an overview of baseline setting for greenhouse gas (GHG) crediting mechanisms. The first section briefly explains the general purpose and objectives of setting a crediting mechanism baseline. The second section summarizes key policy considerations in defining and setting baselines. The final section covers important technical elements of baselines and provides an overview of various methods that can be used to estimate baseline emissions.

The main purpose of this technical note is to examine key issues for baseline setting in the context of scaled-up crediting mechanisms. Many of the technical and policy considerations presented here, however, are relevant to existing project-based crediting mechanisms as well, and the discussion takes into account concepts developed and experience gained under these mechanisms. In addition, most of the concepts and examples presented here are relevant to setting baselines in the energy and industry sectors. Where relevant, however, examples from other sectors – including forestry and land-use – are used to illustrate important ideas.

1. The Role of Crediting Mechanism Baselines in GHG Markets

Very broadly speaking, there are two types of market mechanisms that can be developed to achieve reductions in GHG emissions: *emissions trading systems* and *crediting mechanisms*.

Under emissions trading systems, a limit or *cap* on GHG emissions is established for a predefined set of sources.[1] In most such systems, tradable *allowance* units are issued *ex ante* to regulated participants.[2] Regulated participants must surrender a quantity of allowances equal to the GHG emissions from the sources they own or control (usually measured in tons of CO_2-equivalent). Participants that reduce emissions are rewarded with the opportunity to sell excess allowances (or acquire fewer allowances to meet their obligations). Participants that do not sufficiently reduce emissions have to acquire more allowances and/or are penalized by paying fines for non-compliance. Participation in an emissions trading system is mandatory for entities that own or control sources within the system's boundaries.[3]

Under crediting mechanisms, a *baseline* is established for sources that are outside the boundaries of an emissions trading system. Tradable *credits* are issued *ex post* for reductions in GHG emissions below the level set by the baseline. These credits may be sold to participants in an emissions trading system, for

[1] PMR Technical Note #2 (March 2012) provides an overview of the design elements of domestic emissions trading systems, including a summary of various existing and proposed schemes. It can be downloaded from www.wbcarbonfinance.org/pmr.

[2] Some systems, such as the Alberta Greenhouse Gas Reduction Program and the United Kingdom Emissions Trading Scheme (which ceased operation in 2006), operate on a different model where each source is assigned an individual cap or obligation, and tradable "credits" are only issued *ex post* when a source reduces emissions below its individual cap. Such credits may be purchased and surrendered by sources that exceed their caps in order to meet compliance obligations. Despite this difference in structure, these systems are functionally very similar to cap-and-trade systems with *ex ante* allocations, and may be classified as emissions trading systems for the purposes of this technical note.

[3] Some emissions trading systems allow certain entities (e.g., entities emitting fewer emissions than the threshold triggering mandatory participation) to voluntarily opt into the system; however, once they do so they are legally bound to comply with emissions obligations.

example, who can use them to help meet their compliance obligations (i.e., both allowances and credits may be surrendered for compliance). Participation in a crediting mechanism is voluntary; the entities that own or control eligible sources face no obligation and are not penalized if their emissions exceed baseline levels. Because of this, however, crediting mechanisms rely on external demand for credits to provide the incentive for reducing GHG emissions below a baseline. In most cases, this demand comes from emissions trading systems that choose to make specific kinds of credits eligible for meeting compliance obligations.

Because of the different functions they serve, the policy goals for setting a *cap* and setting a *baseline* are somewhat different. For an emissions cap, the primary policy question is whether the cap sets a limit on emissions that is consistent with overall (e.g., global or national) GHG mitigation goals. In general, this means setting a cap below what GHG emissions would have been in the absence of a market mechanism (often referred to as "business-as-usual," or BAU, emissions). However, caps are not always set this way. They may, for example, be linked to a goal of reducing emissions to historical levels (e.g., 1990 levels) by a certain date, without explicitly referring to what BAU emissions would have been otherwise.

By contrast, the primary policy question for baselines is whether they are set such that only GHG reductions below BAU emission levels – or a level even lower (i.e., more stringent) than BAU – will be credited. This is necessary to ensure environmental integrity. If credits are issued for reductions that were likely to occur anyway in the absence of a crediting mechanism, for example, then the GHG mitigation goals of an emissions trading system recognizing those credits – and its environmental integrity - would be undermined, because global emissions would increase beyond what they would have been if the credits were *not* recognized. Thus, despite the inherent uncertainties in predicting BAU emissions, baselines should always be set with a view towards what BAU emissions would have been.[4]

The remainder of this note focuses on the policy and technical considerations involved in setting baselines for crediting mechanisms.

2. Major Policy Considerations in Setting Baselines

At the most basic level, a baseline is a projection of what GHG emissions would be from a defined set of sources under a certain set of assumptions (generally related to how technologies, behaviors, and/or investment would evolve in the absence of a crediting mechanism). Any baseline-setting exercise, however, will depend on the characteristics and objectives of the crediting mechanism for which it is used and indirectly on the objectives of the broader climate change regime(s) where credits will be used. The first step in setting baselines is to answer some basic policy questions related to the design of the crediting mechanism and the nature and ambition of GHG reductions goals. Specifically, the main questions are:

1. What is the scale of the crediting mechanism and who will it target?
2. Is the goal to reduce GHG emissions in absolute terms, or to reduce GHG intensity?

[4] This does not mean that baselines must always be set *equal* to BAU emissions, only that they must provide assurance that reductions that may have occurred under BAU are not credited. In practice, this may mean setting a baseline that is below BAU estimates – see Section 2.3 for further discussion

3. Is the goal to preserve the environmental integrity of programs that recognize the crediting mechanism's credits or (in addition) to achieve net emissions reductions above and beyond those required by those programs (i.e., beyond pure "offsetting") ?

2.1 What Is The Scale of the Crediting Mechanism and Who Will It Target?

The coverage and scope of a crediting mechanism will define the set of GHG sources to which it applies, and therefore the entities that may potentially participate in the crediting mechanism.[5] The entities that will actually receive credits for undertaking GHG emission reductions are referred to here as *implementing entities*. Under a crediting mechanism, baselines are generally set for each implementing entity in order to determine how many credits they can receive. The scale of a baseline will depend on the scale of the implementing entity.

There are a number of options for defining implementing entities. Under existing project-based crediting mechanisms like the Clean Development Mechanism (CDM), implementing entities are usually in charge of projects at a single installation, operation, or land area involving a limited set of GHG sources or sinks.[6] Under scaled-up crediting mechanisms, implementing entities could also be large institutions – such as governmental agencies, industry associations, or aggregators – responsible for reducing emissions across broad areas or collective groups of installations and operations (e.g., "sectors" of the economy). In most cases, these institutional implementing entities would be responsible for achieving net emission reductions across all sources within the coverage and scope of the crediting mechanism, whereas project-based implementing entities would be responsible for achieving reductions at a subset of sources (e.g., single installations). Finally, under some proposals for scaled-up crediting mechanisms, implementing entities would consist of individual projects or installations, but crediting would be linked to the achievement of GHG reductions below a collective group baseline.[7] In these cases, a baseline would need to be set at the group level as well as (in most cases) for each implementing entity. Table 1 provides a basic typology.

For project-based crediting mechanisms, baselines are often determined through a "bottom-up" process, i.e., individual project proponents develop baselines according to established methodologies which are then approved by regulators. Project baselines may also be determined through a "top-down" process, however, where regulators establish standardized baselines that apply to all projects of the same type.[8] Under scaled-up crediting mechanisms, it will generally make sense for regulators to set both project and collective baselines in a "top-down" manner (perhaps utilizing, for example, techniques

[5] The *coverage* of a crediting mechanism refers to the sectors and geographies to which it applies, while *scope* refers to the specific types of emission sources involved. See PMR Technical Note #1 (p. 6) for further explanation of these terms.
[6] However, the CDM also allows for "Programmes of Activities" (PoAs), where market actors may be aggregators responsible for reducing emissions at multiple sites.
[7] See, for example, Prag and Briner (2012), which describes an option where credits are issued to individual firms ("credits-to-emitters"), but the net number credits available depends on overall performance of groups of emitters relative to a collective baseline ("group performance"), pp. 20-22.
[8] Some CDM baseline methodologies, such as the oft-used consolidated CDM methodologies, could also fit in the "top-down" category.

for establishing standardized baselines such as those being developed under the CDM).[9] Regardless of the scale involved (projects or collective), however, baselines may in principle be determined using any of the general approaches described in Section 3.3, below.

Table 1. Possible Crediting Mechanism Structures, Implementing Entities, and Required Baselines

	Project-Based Crediting Mechanism	**Scaled-Up Crediting Mechanisms**		
Implementing Entities (Credit Recipients)	Individual projects only	Individual projects only	Institutional actor* only	Both individual projects and institutional actors
Baseline required for…	Each participating project	Each participating project Collective group of sources**	Collective group of sources only**	Each participating project Collective group of sources**
Examples	Conventional CDM projects Some CDM PoAs† "Credits-to-emitters" with "individual performance" (see Prag and Briner 2012, p. 20)	"Credits-to-emitters" with "group performance" (see Prag and Briner 2012, p. 20)	"Credits-to-government" with "group performance" (see Prag and Briner 2012, p. 20) Some CDM PoAs††	"Nested" project mechanisms combining both group and individual performance and credit issuance[10]

* For example: national governments, industry associations, or aggregators

** In most cases, this means a baseline would be established for the collective GHG emissions from all sources within the coverage and scope of the crediting mechanism.

† Where GHG reductions are quantified at the level of individual activities.

†† Where GHG reductions are quantified at the level of the entire programme.

For scaled-up mechanisms involving individual entities/projects, project baselines will effectively be components of the collective baseline (since they will represent GHG emissions from some of the same sources covered in the collective baseline). Because of this, it will generally make sense to set project baselines and the collective baseline in a coordinated fashion. This could be done by either:

1. Setting a collective baseline first, and then apportioning this baseline to individual sources within the coverage and scope of the crediting mechanism. For example, a baseline emission factor could be determined for an entire electricity grid using aggregate generation and CO_2

[9] See, for example, Hayashi et al. (2010).

[10] This structure has been proposed for some REDD+ mechanisms, but in principle could be applied to energy sector scaled-up crediting mechanisms as well. To work, it requires reconciling the number of credits issued to projects with credits issued to the government or institutional actor so that total credits issued are consistent with GHG reductions achieved relative to the collective baseline. For a discussion of how this kind of structure could work see, for example, Cortez et al. (2010).

emissions data; this emission factor could then be used to determine project-level baseline emissions for each power plant (or the emission factor could be scaled to each power plant based on fuel type).

2. Setting (standardized) baselines for all individual sources, and then summing (or averaging) these baselines to determine the collective baseline. For example, standardized baseline emissions estimates for each cement plant in a country could be summed to determine an aggregate cement sector baseline (or alternatively, the same standard baseline emission rate used for each plant could also be used to set the collective baseline).

2.2 Absolute or Intensity Reductions?

In general, baseline emissions estimates are a product of two factors:

1. The level of activity associated with a process that generates GHG emissions (commonly expressed as *activity data*, e.g., total units of industrial production or output, such as megawatt-hours, tons of clinker, etc.).
2. The GHG intensity of technologies or practices involved in that process (commonly expressed as an *emission factor*, e.g., tons of CO_2 generated per MWh).

Activity data and emission factors can take many forms, depending on the coverage and scope of the crediting mechanism. A baseline for the power generation sector (or a single power plant), for example, could be expressed in terms of electricity generation (MWh) multiplied by a baseline grid emission factor (t CO_2/MWh). Similarly, a baseline for process emissions from cement production could be expressed in terms of tonnes of clinker produced, multiplied by an emission factor for clinker (t CO2/t clinker).

A key policy decision is whether *both* baseline activity data and emission factors should be set *ex ante* (an "absolute" baseline), or whether to set only the emission factor *ex ante* and use ongoing measurements of actual activity to determine baseline activity data (an "intensity" baseline). With absolute baselines, credits are only issued if *total* emissions are reduced below the baseline (expressed in terms of tonnes of CO2e). Intensity baselines allow crediting for reductions in the *rate* of GHG emissions without regard to total emissions, which may vary according to the level of production (it is assumed that baseline production levels would be identical to actual levels). Intensity baselines are therefore expressed in relative terms, such as tonnes of CO2e per unit of output.[11]

Absolute baselines allow credits to be generated only if *total* emissions are reduced below baseline levels, regardless of underlying economic activity and production. Because of this, they may be compatible with ambitious overall objectives for achieving absolute GHG reductions. In addition, the monitoring, reporting and verification (MRV) needed under an absolute baseline may (sometimes) be more straightforward than under intensity baselines because only total GHG emissions, rather than emissions performance relative to output, needs to be monitored.

[11] Total baseline emissions are determined by multiplying the intensity baseline emission factor by actual activity data (output or production).

The challenge with absolute baselines is that it can be difficult to reliably estimate baseline activity levels *ex ante*. Estimations of future emission trends are typically derived from historical data and sets of assumptions. If economic growth and production levels, for example, turn out to be greater than what was initially assumed, then it may be difficult and costly to keep total GHG emissions below baseline levels in order to receive credit. It may thus be rational, in this context, to consider optimistic assumptions about future economic output in the estimation of absolute baselines, but this could potentially lead to a baseline that results in over-crediting. [12] However, as discussed in Section 1, such over-crediting could undermine the environmental integrity of emissions trading systems or other programs that rely on the credits. Conversely, if credit prices are high enough, an absolute baseline may, in some cases, incentivize reductions in output from targeted installations below what they otherwise would have been[13] (not just improvements in GHG intensity). Depending on the industry or industries targeted, there could be a risk that this could lead to a shifting of production to locations not covered by the crediting mechanism (also known as "leakage"), which could undermine or negate the reductions achieved by the mechanism.[14]

Consequently, all else equal, absolute baselines make the most sense where targeted GHG mitigation activities are expressly intended to reduce activity levels. Perhaps the most salient examples of absolute baselines, for example, are those being proposed for national crediting mechanisms targeting reduced emissions from deforestation and degradation (REDD+).[15] For these programs the goal is to reduce activities associated with deforestation, so an intensity baseline – which assumes actual and baseline activity levels are identical – would generally not make sense.[16]

For GHG mitigation activities intended to reduce only emission rates, on the other hand, intensity baselines may be more appropriate. This will often be the case for crediting mechanisms targeted at energy or industrial sectors where future production levels are difficult to predict (either at the scale of individual installations or for the sector as a whole), and in the context of emerging and growing developing economies where reductions in total production would not be feasible or desirable. Most energy-sector CDM methodologies employ intensity baselines for these reasons.[17] In addition, because intensity baselines do not credit emissions reductions that result from reduced production, they are less

[12] This is also discussed in PMR Technical Note #1, p. 7.

[13] For example, if revenues from the sale of emission credits become higher than the profits from production of relevant output.

[14] There are various factors that may affect the extent of (any) leakage, such as the extent of coverage of the crediting mechanism and the feasibility and economic viability of shifting production outside of the area of coverage.

[15] See, for example, Meridian Institute (2011).

[16] Because absolute baselines are used, leakage associated with REDD+ programs remains a prominent concern and such programs therefore require means to minimize this risk.

[17] Especially at the project scale, it is generally assumed that overall production of energy in the baseline will be the same as actual production (because production may be hard to predict and highly variable, and overall energy demand will be the same in any case). Such intensity baseline tends to be particularly compatible with development goals of host countries, as well as provide an opportunity to not penalize countries in situations of overall suppressed energy demand.

prone to leakage concerns.[18] However, because intensity baselines do not limit crediting based on total GHG emissions, it may be more challenging to align them with ambitious overall objectives for absolute GHG reductions. Some periodic evaluation and updating may be necessary to ensure that crediting mechanisms that rely on intensity baselines remain compatible with broader GHG mitigation goals.

2.3 What Is the Intended Goal for the Crediting Mechanism in Supporting Overall GHG Reduction Objectives?

At a minimum, crediting mechanisms must be designed to ensure the environmental integrity of the emissions trading systems and other programs that rely on the credits they generate. As discussed in Section 1, ensuring environmental integrity requires that baselines be set at a level that is at - or below - BAU emissions. [19]

However, crediting mechanisms may be designed with different goals in mind. One goal may be simply to generate credits that can serve as cost-effective "offsets" to emissions from sources in other programs. Carbon offset mechanisms like the CDM, for example, are premised on the idea of a zero-sum balancing of GHG emissions. Reductions achieved by CDM projects, in other words, allow – in principle – a one-for-one increase in GHG emissions in Annex I countries. In practice, however, even these kinds of crediting mechanisms will generally employ baselines that are conservative, i.e., they will err on the side of underestimating "true" BAU emissions. The reason is that BAU emissions are inherently subject to some uncertainty (see Figure 1). To ensure that environmental integrity is preserved, it will often make sense to set a baseline at the lower end of possible BAU projections (or even below the lower end). CDM project baselines, for example, are generally set according to conservative methodologies (and contain other restrictions to ensure that not all GHG reductions – relative to BAU estimates – are actually credited).

Another possible policy goal, however, is to expressly design a crediting mechanism such that it will, if successfully implemented, generate additional global net GHG reductions relative to a scenario without the mechanism. At the 16th meeting of the Conference of Parties to the United Nations Framework on Climate Change in 2010, for example, it was agreed that new market mechanisms should "[ensure] a net decrease and/or avoidance of global greenhouse gas emissions."[20] One way to do this is to establish a crediting mechanism whose baseline ensures that fewer credits are issued than the total number of tonnes of CO2-equivalent emission reductions achieved relative to BAU.[21] In practice, this would mean setting a baseline that is (potentially significantly) below low-end estimates of BAU emissions (see Figure 1). Setting a baseline below BAU emissions would mean that for every credit issued, global GHG

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[18] However, leakage may still be a risk in some cases, e.g., where measures to reduce the rate of emissions are also associated with relative reductions in output. In these cases, it may be possible to appropriately discount credited emission reductions to limit any risk of undermining environmental integrity.

[19] Conversely, for sequestration activities the baseline must match or exceed BAU sequestration levels.

[20] UNFCCC COP Decision 1/CP.16, paragraph 80; available at http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf.

[21] Note that setting an ambitious baseline (below BAU) is only one possible way to achieve net global GHG reductions using a crediting mechanism. Other options include credit discounting (i.e., issuing less than one credit per tonne of CO_2-equivalent reductions); credit set-asides (which effectively achieve the same result); and using shortened crediting periods (so that ongoing reductions are not credited).

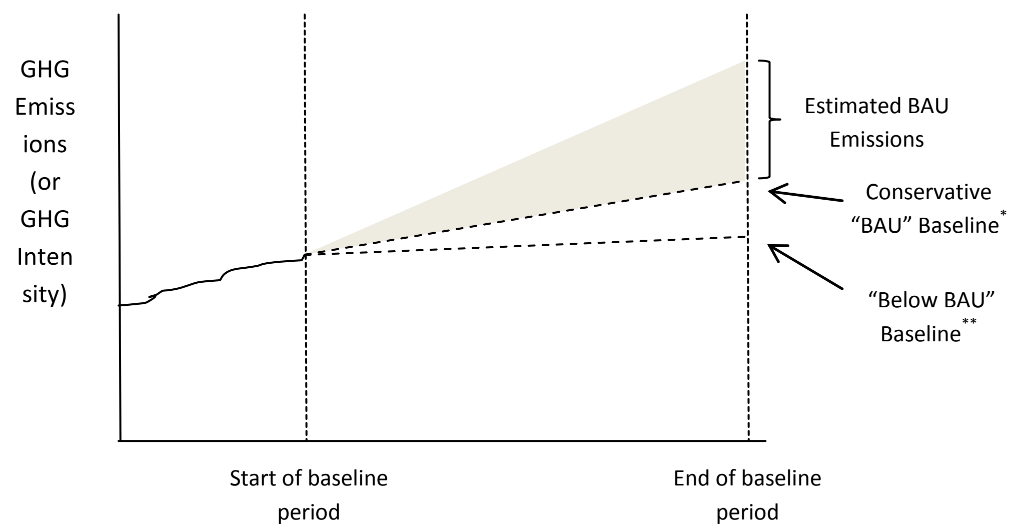
emissions would be reduced by more than one CO_2-equivalent tonne, leading to more net reductions than would have been achieved without the crediting mechanism.

Box 1. "Baselines" vs. "Crediting Baselines" and "Crediting Thresholds"

Some discussions of crediting mechanisms use the terms "crediting baseline" or "crediting threshold" to refer to a baseline that is set below likely BAU levels and will therefore result in some non-credited GHG reductions.[22] In fact, where the policy goal for a crediting mechanism is to achieve additional global net GHG reductions, it may be useful to distinguish between a "baseline" representing BAU emissions, and a "crediting threshold" used for determining how many credits may be generated. Making this distinction helps to make clear precisely what portion of reductions are expected to be credited, and what portion will not be credited (i.e., the difference between the " Conservative BAU" baseline and the "Below BAU" baseline in Figure 1).

In this technical note, the term "baseline" is used (except where otherwise noted) to refer to either concept. The processes for establishing a BAU baseline and a "crediting threshold" that is significantly below BAU are essentially the same. The difference would be in the relative conservativeness of the methods and assumptions used to establish the baseline. Section 3.3 discusses various ways to incorporate conservativeness into baseline assumptions in order to construct an "ambitious" baseline below BAU levels.

Figure 1. Examples of Conservative Baselines Associated with Different Policy Goals



* Conservative baseline designed to ensure environmental integrity

** Conservative baseline designed to ensure environmental integrity and generation additional global net GHG reductions.

[22] For example, see PMR (2011), *Tool for Market Readiness Proposal* and Prag and Briner (2012).

Regardless of the policy goals for the crediting mechanism, care must be taken when setting a conservative baseline to ensure that implementing entities retain sufficient incentive to reduce emissions. The more conservative the baseline is, the fewer the credits implementing entities can receive for any given amount of GHG reductions. If the quantity and price of credits are insufficient to cover the costs of investing in GHG mitigation activities, then economically efficient and effective mitigation actions may go unrealized (compared to a situation with a less conservative baseline, for example). This could represent a significant opportunity cost (not to mention a significant wasted effort on the part of those who established the crediting mechanism). Thus, determining the appropriate level of conservativeness for a baseline will require balancing the policy goals of ensuring environmental integrity,[23] promoting greater net GHG reductions, and providing sufficient incentives for investment.[24]

3 Key Technical Elements of Setting a Baseline

Once the scale, nature, and ambition of a baseline have been decided, actually setting a baseline involves several steps related to common technical considerations. Note that although these steps are highly technical in nature, baseline setting is both a science/technical and a policy undertaking. Decisions related to the various technical elements of a baseline will often involve subjective judgment, and – beyond the general stricture that baselines should be set at or below BAU emission levels (which themselves will be subject to uncertainty) – there is seldom a single "right" answer for how a baseline should be set. The guidance below is intended to provide an overview of the types of decisions that must be made, and does not prescribe particular outcomes.

As mentioned in Section 2.2, baseline emissions estimates are generally a product of two factors: *activity data* and *emission factors*. Setting a baseline involves making assumptions about both parameters. Specifically, baselines are generally constructed by:

1. Estimating activity data under a set of conditions and assumptions (concerning, for example, expected financial incentives, social and economic conditions, and legal/regulatory frameworks).
2. Estimating associated emission factors under the same conditions and assumptions (reflecting, for example, assumptions about the technologies or practices likely to be employed under those conditions).

The most important technical considerations in setting a baseline include:

1. Identifying possible baseline technologies, practices, or conditions
2. Determining for how long the baseline will be valid
3. Choosing an approach to determining baseline activity data and emission factors

[23] Ensuring environmental integrity will also require assurance of robust data and methodologies used to set the baseline. It should be noted that conservatively-set and ambitious baselines alone cannot ensure environmental integrity of a crediting mechanism, transparent and robust MRV of emission reductions will also be required. This may be explored in a future PMR Technical Note.

[24] One possible option for overcoming investment barriers created by an ambitious baseline may be for public-sector actors to compensate private-sector market actors for un-credited GHG reductions. This could give private entities the incentive they need to undertake reductions, while allowing public actors (e.g., host country governments) to fulfill pledges to achieve net GHG reductions. Such a structure would still require a careful balancing of private incentives and public costs/support.

4. Identifying triggers and procedures for updating the baseline

3.1 Identifying Possible Baseline Technologies, Practices, or Conditions

The coverage and scope of a crediting mechanism will determine the types and locations of sources where GHG mitigation activities may occur. Depending on how the coverage and scope are defined, only certain kinds of GHG mitigation activities may qualify for crediting. For example, if the whole electricity sector supplying the national grid is covered, then qualifying GHG mitigation activities could include (among other things) efforts to install more renewables, improve the combustion efficiency of power plants, or improve the efficiency of electricity consumption. If the scope of the crediting mechanism only includes coal-fired power plants, on the other hand, then qualifying activities would include only measures to reduce emissions at those plants. The first step in setting a baseline is to identify the kinds of GHG mitigation activities that might be undertaken within the coverage and scope of the crediting mechanism. The baseline must be relevant to those activities, involving assumptions about activity data and/or emission factors associated with relevant alternatives.[25]

The possible alternatives to GHG mitigation activities are referred to here as *reference technologies, practices, or conditions*. These are only *possible* alternatives; the process of setting a baseline involves making determinations about the timing and composition of reference technologies, practices, or conditions that would prevail under baseline assumptions (taking into account, for example, the level of ambition of the baseline). It is from these determinations that baseline emission factors (and possibly activity data) are derived. Different methodological approaches for determining the baseline are described in Section 3.3.

To identify possible reference technologies or practices, it is often helpful to specify a *product or service* that is produced by sources or facilities within the coverage and scope of the crediting mechanism. Depending on the coverage and scope, the product or service may be broadly or narrowly defined. The generality or specificity with which products and services are defined is sometimes referred to as the *level of aggregation* for the baseline.[26] Table 2 contains some examples of alternative definitions and their implications for baseline aggregation and the identification of reference technologies or practices in the power sector.

Table 2. Examples of Alternative Levels of Aggregation Related to Product or Service (Power Sector)

Coverage and Scope of Crediting Mechanism	All grid-connected electricity production and consumption	Existing and new grid-connected electricity generation	Peaking cycle natural-gas fired power plants
Level of baseline	Highest	High	Lowest

[25] Depending on the coverage and scope of the crediting mechanism, mitigation activities may cause changes in GHG emissions at multiple sources, sinks, and/or reservoirs (SSRs). Some of these changes may be unintended, e.g., if an activity results in "leakage" outside the mitigation boundary to cause a countervailing emissions increase elsewhere. To fully account for net GHG reductions, it may be necessary in some cases to estimate baseline emissions associated with all the SSRs affected by a mitigation activity. In some cases, this could require identifying multiple sets of SSRs and identifying baseline alternatives for each (e.g., "primary" SSRs and "leakage" SSRs). The extent of leakage risks in the context of a scaled-up crediting mechanism covering groups of emitters compared to isolated single project activities is unclear and may warrant further examination. Notwithstanding, in practice, accounting for leakage may be done in a number of different ways, and the appropriate methods will depend on the size of the expected leakage effect and the scale, coverage, and scope of the crediting mechanism.

[26] See, for example, Lazarus et al. (2000) and Kartha and Lazarus (2002).

aggregation			
Definition of product/service	All grid-connected electricity end uses and applications (e.g., defined by the various services electricity provides)	Grid-connected electricity generation (MWh)	Peak-demand electricity generation
Reference technologies	(1) Electricity end-use technologies; (2) Electricity generation technologies & fuels	Current and projected electricity generation technologies (power plants) and fuels	Natural gas power plants designed to serve peak demand
Activity data	MWh consumption associated with end-use reference technologies	MWh generation	MWh generation
Emissions factor(s)	GHG emission rate(s) of generation reference technologies	GHG emission rate(s) of reference technologies	GHG emission rate(s) of reference technologies

For some types of GHG sources, identifying an associated product or service may not be relevant or necessary. This may be true, for example, where GHG mitigation activities involve land-use change or the destruction or avoidance of industrial or waste-gas GHG emissions (e.g., destroying or avoiding N_2O emissions from nitric acid plants; destroying or avoiding landfill methane emissions; etc.). For these kinds of activities, baselines are determined using *reference conditions*[27] rather than reference technologies or practices. However, it may still be appropriate to define a level of aggregation and identify associated activity data and emission factors. Table 3 provides some examples.

Table 3. Examples of Alternative Levels of Aggregation Where No Product or Service Is Involved

Coverage and Scope of Market Mechanism	Landfill methane emissions (all mitigation measures)	Landfill methane emissions (combustion for electricity generation)	Emissions from deforestation and degradation (REDD)	Emissions from deforestation and degradation (REDD) of specific forest types
Level of baseline aggregation	High	Low	High	Medium or Low
Definition of product/service	N/A	N/A	N/A	N/A
Reference conditions	Uncontrolled anaerobic decomposition of landfill waste	Uncontrolled anaerobic decomposition of landfill waste	Deforested/ degraded land area	Deforested/ degraded land area
Activity data	Volume of landfill waste affected	Volume of methane captured & destroyed	Extent of deforestation/ degradation (e.g., hectares)	Extent of deforestation/ degradation of a specific forest type (e.g., hectares)
Emissions factor(s)	Methane emissions per unit of landfill	N/A*	Single forest-wide average CO_2e	Multiple forest-type specific CO_2e

[27] As with reference technologies and practices, reference conditions represent possible conditions that could be used to specify baseline activity data and emission factors. The selection of an appropriate reference condition – or combination of possible conditions – is determined by the approach used to set the baseline – see Section 3.3.

	waste		emissions associated with clearing a unit of land (e.g., t CO_2e/ha)	emission factors (e.g., t CO_2e/ha for each type of forest)

* For this example, the denominator for the emission factor would be a single landfill; baseline emissions may be determined simply from the activity data for the landfill, and an emission factor is therefore redundant.

Finally, the specific reference technologies, practices, or conditions that should be used to establish a baseline will depend on: (1) the geographic areas where GHG mitigation activities occur; and (2) current trends in technology use, practices, or conditions within those areas:[28]

(1) Geographic Area

The kinds of technologies or practices that are commonly used to provide a product or service can vary considerably by geographic region. For example, the mix of power plants in Brazil differs significantly from that in South Africa. Likewise, reference conditions (where relevant), along with associated activity data and/or emission factors, can also vary geographically. For example, methane emissions from landfill waste may vary according to climatic conditions, annual rainfall, and other factors.

Generally, the baseline for any GHG mitigation activity should be based on the reference technologies, practices, or conditions found within the geographic area where the activity is taking place. The geographic area may be broadly or narrowly defined (e.g. a city, a state/province, a country or a region covering several countries) and drawing appropriate geographic boundaries will depend on a number of considerations. Broadly speaking, the geographic area should be defined by common conditions or characteristics that may influence the adoption of relevant technologies or practices, or that would determine reference conditions. Depending on the type of targeted GHG mitigation activities, for example, the appropriate geographic area may be defined by:

- *Common social or cultural characteristics*. Such factors would be appropriate to consider, for example, where adoption of alternative technologies or practices is mediated by social or cultural norms.
- *Common economic circumstances*. Economic conditions may significantly influence the types of technologies or practices used to produce products and services.
- *Common legal frameworks and jurisdictional boundaries*. Government policies and legal requirements may help drive economic conditions, and may directly promote or discourage the adoption of certain types of technologies or practices.[29]
- *Physical infrastructure constraints.* Relevant reference technologies may be defined by the physical systems or infrastructure to which an actor is connected, e.g., electricity grids.
- *Common biophysical, climatic, or ecological characteristics.* These characteristics may be particularly relevant for defining reference technologies, practices, and conditions related to land use, building energy efficiency, waste management, etc.

Depending on the range of common conditions or characteristics, the geographic area could be as small as a municipality or small ecological zone, or as large as the entire world.

[28] For further discussion on how to define geographic and temporal constraints on baseline alternatives, see Sathaye et al. (2004), Murtishaw et al. (2006), and WRI/WBCSD (2005).
[29] If an implementing entity is itself a governmental jurisdiction, then the relevant geographic area could in many cases be defined by the boundaries of the jurisdiction.

(2) Temporal Trends and Vintages

In identifying specific reference technologies, practices, or conditions, it may also be important to consider how technologies, practices, or conditions are changing over time. For example, for a market mechanism targeting efficiency improvements in new commercial boilers, baselines could be set by referring to the efficiency of existing commercial boilers within an appropriate geographic area. However, the existing set of commercial boilers may consist of some very old boilers with low efficiencies, newer boilers with high efficiencies, and others in between. In most cases, only more recently installed boilers will provide a good indication of what is likely to be installed in the future (under baseline conditions). Thus, the baseline should be set by considering only the emission factors of recent vintages of boilers (e.g., using one of the approaches described in Section 3.3).

Some general criteria for when and how to consider temporal trends (i.e., specific vintages) in identifying reference technologies, practices, or conditions include the following:

- If the market mechanism is designed to incentivize retrofits, operational improvements, or accelerated shutdowns at existing installations, then existing (new and old) technologies or practices could serve as a reference – along with examples of recent retrofits or improvements at those facilities.
- Where technological or practice changes are occurring slowly, it may be appropriate to also consider older installations or operations as reference technologies or practices.
- Where technological or practice changes are occurring rapidly, reference technologies or practices should generally be based only on recent vintages. In some rapidly changing contexts, it may be most appropriate to base reference technologies or practices on future planned installations or technologies/practices that have been newly introduced.
- The choice of which vintages to consider in identifying reference technologies or practices may also depend on the intended ambition of the baseline. Including only recent, lower-emitting reference technologies and practices would typically result in a more ambitious baseline than one that includes older technologies and practices as well.

3.2 Determining for How Long the Baseline Will Be Valid

Any projection about baseline GHG emissions will be subject to uncertainty. In general, the further into the future one attempts to look, the more uncertain baseline projections become. The greater the uncertainty, the harder it is to be confident that a baseline will provide an accurate and effective benchmark for assessing progress in reducing GHG emissions. A baseline that overestimates emissions can undermine the achievement of GHG mitigation goals and threaten the environmental integrity of a market mechanism. A baseline that underestimates emissions (i.e., that is overly stringent) may unnecessarily weaken incentives for implementing entities to reduce emissions. Because of these risks, policymakers must decide for what period of time a baseline should remain valid.

Deciding on a valid baseline period involves weighing the risks of increasing uncertainty about baseline emission levels against the need to provide implementing entities with a reasonable degree of investment certainty. A baseline period that is too short may provide implementing entities with too little predictability and too little incentive to make optimal investments, because it affords too limited an opportunity to monetize GHG reductions. A longer baseline period but with periodic updating of key assumptions can provide implementing entities with more opportunity, but investment may still be discouraged because of the difficulty in knowing what performance will be measured against once the baseline is updated (see discussion in Section 3.4).

The CDM has addressed these tradeoffs by offering project developers two options for the valid term of a baseline (referred to as a "crediting period"). Specifically, project developers may opt for:

- A single crediting period of 10 years, with no opportunity to extend the baseline.
- Up to three seven-year crediting periods, in which case the baseline must be updated for each seven-year interval.

This "two sizes fit all" approach to the baseline period appeared to strike a reasonable balance for many project-based carbon offsets. In designing new market mechanisms, however, it may make sense to tailor the baseline period to the particular circumstances of the mechanism and the activities it targets. Some general considerations include the following:

- *What is the typical investment horizon for the kinds of activities targeted by the mechanism?* For targeted activities that are capital intensive and produce GHG reductions over long periods, for example, a longer (10+ years) baseline period may be desirable or even necessary.
- *What is the expected duration of the market mechanism itself?* If it is envisioned that the market mechanism will have a limited lifetime (after which it will be replaced by some other program or policy, for example), then – all else equal – it may make sense to equate baseline periods with the duration of the mechanism. If the market mechanism is expected to be in place for a long time (or indefinitely), then baseline periods should be set according to other factors.
- *How rapidly and predictably are conditions relevant to the baseline changing?* Baseline estimates will almost always be based on assumptions about social, economic, technological, or physical factors that drive the production of GHG emissions. These factors will frequently change over time. The more rapidly and unpredictably they change, the more likely it is that the initial assumptions used to set a baseline will be incorrect as time passes, resulting in emissions estimates that are too high or too low. If key variables are likely to change rapidly and unpredictably, a shorter baseline period should generally be used. (It may also be important to set clear and predictable triggers for the updating the baseline prior to the end of the baseline period, if the need for updating is anticipated – see further discussion in Section 3.4.)
- *How conservative are baseline emissions estimates?* One way to address uncertainty about baseline emissions is to use conservative estimates (e.g., assumptions about baseline activity data and emission factors that result in lower emissions totals). Notwithstanding how much uncertainty there may be about future baseline emissions, using an ambitious baseline based on conservative estimates will help to minimize the risk of undercutting environmental integrity. In these cases, a longer baseline period may be justified. The benefits of a longer baseline period, however, would need to be weighed against the possible investment disincentives caused by a potentially over-conservative/ambitious baseline (as discussed in Section 2.3).
- *How frequently can data be obtained to update the baseline?* If a baseline will be "renewed," i.e., updated and extended based on new data, it may be important to consider how difficult or costly it will be to obtain updated data. All else equal, it may make sense to set a baseline period that corresponds to a reasonable timeframe for acquiring the data needed to update the baseline..

3.3 Choosing an Approach to Determine Baseline Activity Data and Emission Factors

As noted above, baselines are calculated – at the broadest level – by combining activity data and emission factors to produce a total GHG emissions estimate. Activity data during the baseline period can either be directly measured (in the case of an intensity baseline), or must be projected somehow. Emission factors are generally determined by reference technologies, practices, or conditions. However, methods must be chosen for determining which reference technologies – and in what combination – will be most appropriate for representing baseline emissions.

There are three general approaches to projecting baseline activity data (also summarized in Table 4):

1. *Use actual data.* In many (if not most) instances, actual measurements of activity data may be used to estimate baseline activity data. This will usually be the case for intensity baselines.
2. *Extrapolate from historical data*. It may often be appropriate to estimate future baseline activity data by looking at recent historical activity. This approach makes sense if the market mechanism is targeting GHG mitigation activities at existing facilities (or activities related to land use) *and* – in the absence of a GHG market mechanism – activity levels are not expected to change significantly relative to historical patterns. One key consideration is how far back in time to collect data in order to establish an appropriate projection. (The quality and robustness of the historical data are another key consideration here.) Care must be taken to ensure that conditions during the historic period are indicative of conditions that are assumed for the baseline period, i.e., is the recent past a good proxy of the (near) future? Another key decision is whether to use average historical activity levels or a projection of activity trends to set the baseline. If activity levels exhibit a clear trend up or down over time, then the trend should generally be extended into the baseline period.
3. *Use financial, economic, engineering, or behavioral modeling*. If a market mechanism is targeting GHG mitigation at new facilities (e.g., incentivizing the use of low-emitting technologies instead of higher-emitting ones in new construction), then there may be insufficient relevant historical activity data with which to set a baseline. Similarly, if conditions affecting activity levels are expected to change significantly going forward (in the absence of a market mechanism), then historical data may not be indicative of baseline trends. For example, new legal requirements, economic conditions, technology shifts, or physical constraints (e.g., the exhaustion of a natural resource) may make historical data a poor indicator of future activity levels. Under these circumstances, some kind of modeling effort will be needed to estimate baseline activity data. The type of model (e.g., a top-down macro-economic type of model, or a more bottom-up micro-economic model) will depend on the nature of the GHG mitigation activities being targeted, the scale of the implementing entities (e.g., individual installations, or collective groups of installations and sources), and the level of complexity and sophistication needed to predict future activity trends.

An overarching consideration in choosing an approach is the availability and quality of underlying data. Extrapolating from historical trends may be untenable if sufficient data are not available, or if the data contain significant gaps or uncertainties. Similarly, most models require significant quantities of accurate data in order to produce robust results. All else equal, data constraints may influence the type of approach that is deemed to be most appropriate. Where data are limited, the use of conservative assumptions about activity data may be required.

Building Conservativeness into Baseline Activity Data: For intensity baselines, it will generally not make sense to try to build conservativeness into activity data estimates (activity data will be determined by actual measurements). Instead, conservativeness will be reflected in the choice of emission factors (discussed below). For absolute baselines, if the underlying baseline activity data will be projected, an ambitious baseline can be achieved by specifying activity levels that are below projected BAU levels. For example – and where appropriate, the baseline could be determined by assuming activity levels that are X percent below the levels projected using historical extrapolation or modeling – but this may be challenging in some cases to reconcile with a country/region's broad development and growth objectives. Alternatively, models may employ conservative assumptions for variables related to growth in activity levels.

Table 4. Approaches for Estimating Baseline Activity Data

Approach	Applicable Where…	Pros and Cons	Examples
Use actual data	Baseline activity data are not expected to differ from actual activity data Actual activity data are easy to acquire Absolute emission reductions are not necessarily required (see prior discussion)	**Pros:** Requires no additional modeling or analysis. **Cons:** May not always be applicable or appropriate	Baselines for most crediting mechanisms targeting energy production (e.g., CDM methodology for renewable power generation, ACM0002)
Extrapolate from historical data	Activity data are being projected for existing facilities or sources Historical activity data are available Future activity data are likely to continue historical trends (in the absence of a market mechanism)	**Pros:** Relatively easy and low-cost where historical data are available **Cons:** Historical activity may not always be a good predictor of future activity; this may limit the valid baseline period or require supplementing projections with modeling results Sufficient, high quality historical data may not always be available	Most baselines proposed for REDD+ mechanisms
Use a model	Activity data are being projected for existing or new facilities or sources	**Pros:** May provide more appropriate estimates of baseline activity than	Absolute baseline for the power sector where future generation levels

	Historical trends are not a good indicator of projected trends	historical extrapolation **Cons:** Modeling may be costly and time-consuming, depending on the type and sophistication of the model. Simpler models may not provide accurate projections (e.g., consistent with ensuring BAU levels are not exceeded). Accurate modeling may require significant amounts of input data.	are expected to diverge from historical trends

As with activity data, there are also three general approaches to projecting baseline emission factors (also summarized in Table 5):

1. *Assume the continuation of current technologies, practices, or conditions*. Where GHG mitigation activities cause reductions at existing sources, it will often make sense to use the actual technologies, practices, or conditions present at those sources (prior to any mitigation action) to determine baseline emission factors. The assumption is that, in the absence of any mitigation action, the sources would continue to operate or maintain the same technologies, practices, or conditions and emit GHGs at the same rate as before. However, this assumption may not be valid in all circumstances. If an industrial boiler, for example, would have switched fuels or been retrofitted under baseline conditions, then its baseline emission factor should reflect the effects of those changes – at least after the point in time when the retrofit would have occurred. If changes in existing technologies, practices, or conditions are likely to occur under baseline assumptions, then the baseline should either: (1) have a baseline period that does not extend beyond the point when changes are expected; or (2) adopt different emission factors for different time periods. Emission factors for upgrades, retrofits, or other changes may be determined using either general approach #2 or #3, described below.
2. *Identify discrete baseline alternatives using environmental, financial, economic, or behavioral analysis or modeling*. Where baseline emission factors must be estimated for new sources – or for changes or upgrades to existing sources – a method must be employed to identify which reference technologies, practices, or conditions best represent the baseline. One option is to identify discrete baseline technology or practice choices based on an analysis of environmental, financial, technical, social, cultural, or other factors that might drive their adoption. For example, the crediting baseline emission factor for a new power plant could be determined by identifying a group of reference technologies (as described in Section 3.1), and then identifying a specific generation technology that would have been adopted in the baseline according to an analysis of capital costs, fuel prices, electricity prices, expected energy demand, etc. A similar

but larger-scale analysis (e.g., using a production cost model) could be undertaken for an entire electricity grid in the case of a scaled-up market mechanism.

3. *Establish a performance standard or benchmark indicative of baseline trends*. An alternative to identifying discrete baseline reference technologies, practices, or conditions is to set emission factors using performance standards or benchmarks.[30] In general, performance standard approaches identify an emission factor based on either: (1) a blend of reference technologies, practices, or conditions (e.g., a weighted average, or below-average percentile, of reference technology emission rates)[31]; or (2) a single generic reference technology, practice, or condition that serves as a benchmark. Performance standards are generally used to estimate baseline emissions for multiple GHG sources, in lieu of identifying discrete alternatives specific to each source (as in approach #2). As such, they may need to be regularly updated to ensure that they continue to reasonably represent the baseline for new market entrants (or for changes in practice or technology at existing sources) – and thus continue to ensure environmental integrity. Many of the same considerations that apply to updating baselines (Section 3.2) will also apply to updating performance standards.[32]

As with activity data, the approach to determining emission factors may depend to a great extent on data availability. In particular, developing performance standards or benchmarks will generally require extensive datasets on reference technologies, practices, or conditions. Likewise, analysis or modeling may also be data and resource-intensive. Where data quantity and quality are limited, it may be necessary to adopt conservative assumptions about reference technologies, practices, or conditions, their emission factors, and associated baseline emissions.

Table 5. Approaches for Estimating Baseline Emission Factors

Approach	**Applicable Where…**	**Pros and Cons**	**Examples**
Assume continuation of current technologies, practices, conditions	Baseline is for existing facilities/sources Existing sources will continue to operate or maintain current	**Pros:** Generally straightforward; emission factor data are relatively easy to obtain **Cons:** Not applicable if	CDM methodology ACM0007, where the baseline for upgrading a natural gas power plant is (in part) determined by the emission factor of the

[30] For a full discussion of this option, see for example Hayashi et al. (2010).
[31] See, for example, Sathaye et al. (2004) and WRI/WBCSD (2005).
[32] Note that updating of performance standards may be done on a distinct schedule from the updating of baselines, and will generally not affect baselines already established for market actors. For example, a performance standard established for 2012 could be used to set the baseline for any new market actors in 2012, whose baselines might at that point remain unchanged for a period of seven years. Market actors beginning activities in 2013 would adopt the 2013 performance standard, which would likewise set the baseline for those actors for another seven years. The regular, dynamic updating of performance standards is sometimes confused with the notion of a dynamic baseline, i.e., where the baseline for a single actor is regularly updated during the baseline period; see, for example, the proposal for a "dynamic baseline" by the International Energy Agency for (IEA 2009) where it is noted that "this [dynamically updated] crediting baseline *would apply only to new plants*" (p. 79, emphasis added). A true dynamic baseline would be one that is regularly updated for the same plant(s).

	technologies, practices, conditions	technologies/practices/ conditions at existing sources are changing	pre-existing (single cycle) plant[33]
Identify discrete alternatives	Baseline is for new facilities/sources, or for changes/upgrades at existing facilities/sources Ambitious baseline is desired for existing sources	**Pros:** In theory, provides the most robust method for determining BAU emission factors for new or changing facilities/sources **Cons:** Can be time-consuming, costly, and subjective to implement; accuracy (or conservative-ness) may depend on the quality and sophistication of the data, analysis, and/or models used	Procedure described in the CDM "Combined tool to identify the baseline scenario and demonstrate additionality"[34]
Use performance standards	Baseline is for new facilities/sources, or for changes/upgrades at existing facilities/sources Ambitious baseline is desired for existing sources	**Pros:** Provides a streamlined way to estimate baseline emission factors for multiple sources & implementing entities **Cons:** Data intensive; requires upfront research & analysis to identify an appropriate benchmark; may be costly to maintain and update	Climate Action Reserve protocols for ozone depleting substances and livestock methane (which use benchmark practices to determine emission rates)[35] U.S. Climate Leaders protocol for commercial boilers, which uses performance standard emission rate[36] UNFCCC initiative to develop standardized baselines, pursuant to Decision 3/CMP.6.

Building Conservativeness into Baseline Emission Factors:

- If the baseline is being established for existing facilities or sources, a conservative baseline can be achieved by using alternative (and/or more efficient) reference technologies, practices, or conditions to determine a baseline emission factor, rather than assuming the continuation of current activities or conditions. For example, the baseline emission factor for an existing power plant could be determined using a performance standard – regardless of whether any changes or upgrades to the power plant would be expected under BAU.
- If the baseline is being established for new facilities or sources, a conservative baseline can be

[33] http://cdm.unfccc.int/UserManagement/FileStorage/QIAWJ1LEVG8X64SBFDUZ50TH7RY3PN
[34] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v4.0.0.pdf
[35] http://www.climateactionreserve.org/how/protocols/
[36] http://www.epa.gov/climateleadership/documents/resources/comm_boiler_proto.pdf

achieved by:
  - Using conservative assumptions or metrics to evaluate discrete alternatives.
  - Setting an aggressive performance standard or benchmark for the baseline emission factor, rather than identifying a discrete BAU reference technology, practice, or condition. Setting an ambitious benchmark may require an analysis and projection of BAU technology and practice trends, in order to ensure that the benchmark represents an emission factor that is below BAU.
- If a baseline is being established for an overall area group of entities, including both existing and new (such as under a scaled-up crediting mechanism, for example), a combination of both approaches identified above may be appropriate.

Finally, it should be noted that individual implementing entities may undertake GHG mitigation activities that affect multiple sources of emissions. In these cases, multiple approaches to determine activity data or emission factors may be combined to estimate total baseline emissions. For example, upgrading a single-cycle power plant to combine-cycle operation may reduce the emission rate of the plant itself, and may also displace emissions from existing grid-connected power plants and avoid the need for new capacity (e.g., if output of the plant is increased). Estimating total baseline emissions for the plant would therefore involve identifying three different emission factors: one for the pre-existing single-cycle power plant (using emission factor approach #1), one for existing grid-connected power plants (using approach #1), and one for baseline capacity additions (using approach #2 or #3).[37] Similarly, for a scaled-up crediting mechanism designed to achieve GHG reductions across an entire industry, separate emission factors for both existing and new production capacity may need to be identified to estimate total baseline emissions.[38]

3.4 Identifying Triggers and Procedures for Updating the Baseline

In most cases, key assumptions used to determine baseline emissions will be fixed *ex ante* for the duration of the baseline period. For intensity baselines, this means baseline emission factors will be set in advance.[39] For absolute baselines, assumptions about both emission factors and activity data may be set in advance. A major advantage of using fixed assumptions is that it provides greater investment certainty. Implementing entities will know in advance how well they need to perform – either by reducing emissions rates or overall emissions – in order to receive credits. This allows them to make investment decisions based on technology and implementation costs, performance risks, and the expected price of credits, without having to worry about changes in the metric used to evaluate their performance.[40]

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[37] See, for example, CDM methodology ACM0007 (http://cdm.unfccc.int/UserManagement/FileStorage/QIAWJ1LEVG8X64SBFDUZ50TH7RY3PN).

[38] See, for example, IEA 2009.

[39] This does not mean that emission factor values must be constant or level over the baseline period. They may increase or decrease over time according to assumptions about how emission factors will change. For example, a baseline emission factor could be set – ex-ante - assuming an autonomous energy efficiency improvement of X% per year every year.

[40] Such certainty may help make some projects more bankable by being able to better gauge the likely quantity of emission credits.

Notwithstanding the benefits of investment certainty, there may be instances where it is desirable or necessary to update baseline assumptions during the course of the baseline period. The main reason for doing so would be to ensure the continued validity or conservativeness of the baseline. For example, new information may come to light suggesting that initial baseline assumptions are no longer correct, or are more or less conservative than originally intended. This can occur for numerous reasons, e.g., because conditions change rapidly, or because full information about technology costs and mitigation options was not available to decision makers when baseline parameters were specified.[41]

Under some existing crediting mechanisms, regular and frequent updating of baseline assumptions has been expressly allowed for some kinds of project activities. For example, the CDM baseline methodology for grid-connected renewable energy generation (ACM0002) provides an option where baseline emission factors (i.e., t CO_2/MWh) may be determined annually using emissions data from the operation of existing power plants.[42] The rationale for allowing annual updating is that it provides a more valid approximation of what GHG emission factors would have been in the baseline, i.e., reflective of actual grid dispatch patterns. Experience with this option, however, has largely shown it to be costly and impractical. In general, the relatively minor improvements in the "accuracy" of grid emission factors have been outweighed by the cost – as well as delays – of annually obtaining the required data and the uncertainty it generates for project investors. As a result, most CDM renewable energy projects have chosen not to use this option and have instead opted to use fixed *ex ante* emission factors.

A similar logic is likely to apply to scaled-up crediting mechanisms. In general, it will make more sense – and be more practical - to adopt *ex ante*, fixed, conservative assumptions for key baseline parameters than to try to update them during the baseline period. Nevertheless, the consequences of getting baseline parameters wrong for scaled-up mechanisms could be significant. An emission factor that turns out to be insufficiently conservative could undermine a crediting mechanism's environmental integrity. One that is too conservative could deter overall investment. Thus, particularly in the case of scaled-up crediting mechanisms, it may be desirable to allow updating under predefined circumstances. If updating is allowed, it will be important to clarify the circumstances that could trigger an update as well as the policies and procedures that will be followed.

Triggers for Updating a Baseline

A "trigger" for updating a baseline is a condition - or set of conditions - that must be satisfied before the baseline may be updated. Depending on circumstances, a single trigger or multiple triggers might be defined. Key questions include:

- *What criteria will be used to trigger an update?* Triggers will generally be linked to key assumptions used in estimating baseline emission factors or activity data. Examples of triggers could include:
  - Fuel prices deviate by more than X% from initially assumed values.
  - Relevant technology costs (e.g., for reference technologies) deviate by more than X% from initially assumed values.

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[41] This could occur, for example, due to basic information asymmetries between government agencies and the industries covered under the crediting mechanism.

[42] http://cdm.unfccc.int/methodologies/DB/C505BVV9P8VSNNV3LTK1BP3OR24Y5L. Specifically, the methodology allows "operating margin" emission factors to be determined annually on an *ex post* basis if project developers choose to do so (see the "Tool to Calculate the Emission Factor for an Electricity System," Version 02.2.1, pp. 5-6).

   - Market penetration rates for reference technologies or practices (e.g., in a “control” region outside the scope and coverage of the crediting mechanism) differ from initially assumed rates.
   - Actual measured emissions rates for reference technologies, practices, or conditions differ by more than X% from initially assumed values.
   - Industrial production levels (e.g., used to determine activity data) deviate by more than X% from initially assumed levels.

  Triggers could be linked to meeting several criteria in combination, or could be linked to meeting any one of several criteria. The more clearly and precisely triggers are defined, the better the outcomes in terms of providing predictability for implementing entities.
- *What data sets will be consulted in determining whether an update is necessary?* For clarity and transparency, it will generally be a good idea to identify the specific data sources that will be used in determining whether a trigger criterion has been met (e.g., official fuel price indexes, technology cost surveys, market reports, etc.).

Policies and Procedures for Updating a Baseline
In addition to identifying specific triggers for an update, it is important to have clear policies on how updates will be undertaken and applied. Key questions include:

- *What is the maximum allowable frequency for updates?* In general, updating should be a rare occurrence. However, to enhance predictability it may be desirable to establish a policy on the maximum frequency of updates. Updating could be tied to the timing of the release of new data, for example, or a policy could be established to review data and update the baseline – if necessary – only once midway through the baseline period.
- *When will an update take effect?* If a baseline parameter (e.g., emission factor) is updated, it will be important to clarify when the update will take effect. Depending on the circumstances, implementing entities may need time to plan and prepare for any baseline revisions.
- *To what period will updates apply?* Similarly, it will be important to clarify how updates will be applied. In most cases, an updated baseline would be used only for determining GHG reductions going forward. In some cases, new information might justify a retroactive adjustment to GHG reduction calculations. Since the possibility of retroactive adjustments could be detrimental to investment certainty, however, policies for when they might be applied (if ever) should be clearly stipulated.
- *Are there any constraints on the allowable magnitude of an adjustment?* For purposes of predictability, it may make sense to establish bounds on the extent to which baseline parameters are allowed to change. For example, it could be specified that baseline emission factors will not be changed by more than X%, notwithstanding data indicating more significant changes in the actual emission rates of reference technologies. Setting such bounds could reduce uncertainty risks for implementing entities, but would need to be weighed against possible increased risks for environmental integrity.

4 Conclusions: The Need for Practical Testing for Scaled-Up Crediting Mechanisms

This short technical note provides an overview of baseline setting for greenhouse gas (GHG) crediting mechanisms and identifies the key technical and policy issues to be considered for baseline setting, drawing from the literature and practical experience in baseline-setting – which is mostly project-based.

Many of the same principles and procedures that apply to baseline setting for project-scale crediting mechanisms will also apply to scaled-up crediting mechanisms. Policy considerations related to scope and coverage, and to conservativeness and environmental integrity, will apply to scaled-up mechanisms just as they do for project-based mechanisms. The key technical steps in setting a baseline – identifying reference technologies, determining a baseline period, and choosing an approach for determining emission factors and activity data – will be very similar in nature. However, scaled-up crediting mechanisms will also introduce new qualitative and quantitative considerations. For example, a scaled-up mechanism may involve different kinds of implementing entities – including institutional actors – that introduce new dimensions to the data collection and monitoring required. Scaled-up mechanisms may present new policy considerations regarding the appropriateness and feasibility of using intensity or absolute baselines. With respect to conservativeness and environmental integrity, it may make sense to establish “crediting thresholds” for scaled-up mechanisms that are distinct from a strictly business-as-usual baseline. And although the technical approaches available to determine baseline activity data and emission factors may be categorically similar, the data collection and (in some cases) modeling efforts required may look different for scaled-up mechanisms relative to project-based mechanisms, given their expected larger scale and broader boundary (which may necessitate more comprehensive modeling and analysis) . Finally, different policies and procedures for updating may be required for scaled-up baselines than for project-level baselines.

Since baseline setting policies and procedures for scaled-up crediting mechanisms are still untested, the overview presented in this technical note should be seen as a starting point for their development and elaboration. Further practical testing of such mechanisms will be needed to draw further insights and formulate additional guidance specific to their development.

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