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WHAT IS AND HOW TO SET BASELINES FOR CDM PROJECTS?

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Summary

Baseline setting is a key step in the process to identify certified emission reductions for CDM. However, it is not well known how to set baseline, or even what the baseline is.

This paper defines and categorizes some otherwise confusing concepts regarding baseline setting, such as time-dependence (static/dynamic/revision) and standardization (benchmarking/project-specific).

There are many technical aspects for the development of CDM scheme from baseline setting. A Credible and consistent standardization process is one of the most important points for the future development of CDM. This paper clarifies the characteristics of two approaches (benchmarking and project-specific) for standardization and their possible usage. Because of its step-wise nature of CDM scheme development, a CDM Reference Manual approach may provide a credible framework for baseline standardization development as well.

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1. Introduction

Baseline setting is technical but one of the key elements for CDM, as the baseline is the basis for evaluation of emission reductions through project activity. This paper aims to make clear the issues related to setting the baseline and to identify the origin/source of contentious aspects focusing on the technical aspects of baseline issues.

We see some confusion coming from the ambiguous usage of terminology. Even more so, the underlying concepts are not well defined or misunderstood. Clarification of these terms and concepts is the first step for mutual and better understanding of the issues.

Another factor is how to standardize the baseline methodologies. Unfortunately, there remains a large understanding gap as to how to standardize the methodologies. The biggest one is how to understand and make use of the benchmarking (multi-project) approach. The lack of a guiding principle of "most probable scenario without the project" makes it difficult to apply the benchmarking approach. Another gap is related to the fact that it is possible and reasonable to standardize in a project-specific approach. It should be noted as well that there is no connection between the standardization and simplicity of the methodology, in general. What is important is whether we can set up a firm, consistent and unambiguous scheme for the baseline setting. The CDM Reference Manual may provide a good framework for procedural step-by-step development of the methodologies.

This paper deals with the terminology and concepts identification in the following section, mainly focusing on the time-dependence issue. Section three is for the estimation and re-estimation of baseline emissions in the project cycle. Many aspects of standardization are discussed in section four, distinguishing benchmarking (multi-project) and project-specific approaches, and focusing on their step-by-step nature.

2. Concepts Identification

2.1. What is “Baseline”?

Baseline is the reference scenario to evaluate the emissions reductions, *i.e.*, emission reductions are defined by baseline emissions minus emissions by the project. Article 12.5 (c) of the Kyoto Protocol states emission reductions as:

> *Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.*

This is seen as the *definition* of baseline, although it does not mention the word baseline explicitly.

However, we must recognize that the baseline scenario can never be observed in principle. In other words, it is a counter-factual state. This implies that we cannot obtain a numerical value of ‘true’ baseline emissions. Baseline setting is only an artificial ‘definition’ of the reference scenario that is most (or more) likely to occur in the absence of the project.

It should be noted that some parameters used in the project case (*e.g.*, output kWh of the project) are used to calculate baseline emissions, which are emissions in the counterfactual ‘parallel world’.

2.2. Terminology

In the discussion of baseline issues, much confusion arises through the ambiguous or not clearly defined usage of terminology. Here some key terminology related to the word “baseline” is defined:

- **Baseline**:
  This term is used only for “a general concept (equivalent to baseline scenario)” in reference to a project, with little room for misunderstanding. Otherwise, “baseline” is used as an adjective, like “baseline emissions” or “baseline methodology.”

- **Baseline emissions**:
  Baseline emissions $BE(t)$ are an emission trajectory in the case of baseline scenario. Generally, it is a function of time t with a unit of ton-CO_2(eq.)/year. Mathematically, $BE(t)$ is a functional of some parameters (variables) $p_i(t)$, such as the product of output and intensity. In this example, output (*e.g.*, kWh) and intensity (*e.g.*, ton-CO_2(eq.)/kWh) would in general both be time-dependent parameters. Output is an *external* factor set to be equivalent to the output of the

project case; however, we do not differentiate the parameters in relation to attributes concerned.[1] Baseline emissions are the quantity from which to derive emission reductions. In other words, determining the baseline determines baseline *emissions*. It can be misleading to use the single word "baseline", which sometimes means "emission intensity (factor)" or "baseline scenario (case)".

- **Baseline approach**:
  Here we define the word "approach" for "project-specific approach" and "benchmarking approach". The word "methodology" is used for those within each approach.

- **Baseline methodology (set)**:
  Baseline methodology is a *methodology* to calculate baseline emissions *BE*, and is expressed as *a set of formulae* consisting of various (time-dependent) parameters (variables) $p_i(t)$ as $BE(t) = f(p_1(t), p_2(t), p_3(t), \ldots; t)$. When generalized for the purpose of standardization, a set of baseline methodologies takes the form of a flow chart (or decision tree) with various *characterizations* (*branchings*).[2] In this paper, "baseline determination" means to determine baseline *methodology* applied to the project. "Project-specific" and "benchmarking" are categorized in "approaches" as described above, not in "methodologies".

- **Baseline standardization**:
  Baseline standardization is the standardization of baseline *methodology*, *not* that of fixing the emission intensity (output per unit emission). "Standardization" means to apply the *same* methodology for calculation of baseline emissions to *similar* type of projects. The *similarity* is defined by defining the *applicable range* of the parameters and concept in the methodology. Several standardized methodologies can form a set of methodologies to cover broader category of *similar* projects.

2.3. Time-Dependence

It is confusing to use the terminology *static* or *dynamic* to characterize the time-dependence of the baseline methodology or baseline emissions. For example, sometimes the concept "static baseline" is used for (1) time-independence of baseline emissions, (2) time-independence of a baseline emission factor (intensity), or (3) linearly decreasing baseline emission factor. This paper refrains from use of the words *static* or *dynamic* to avoid confusion.

Another ambiguity related to the time-dependence comes from the usage of *revision*. The term *revision* is sometimes used for, *e.g.*, (1) revising standardized methodology (set) for a type of project, (2) revising the applied methodology for some specific project, or

[1] The $BE(t)$ can include *explicit* time dependence, in addition to the *implicit* time dependence through the time-dependent parameters $p_i(t)$. This case is only the *revision* of the baseline methodology. See figure 1 for the revision of baseline.

[2] See figure 4 for an image of a standardized methodology set.

(3) re-evaluation of baseline emissions at regular intervals using non-revised methodology (formula). It is also important whether such revision is applied according to a planned or unplanned schedule, and whether or not the application is retroactive.

The time-dependence concepts related to the baseline setting are categorized as follows:

1. Baseline emissions are expressed as a single formula set of methodology that is implicitly time-variant through the parameters (variables) in it.
   (a) Intensity (emission factor) is invariant, while output is time-variant (if baseline emissions are expressed as output times intensity);
   (b) Both intensity and output (all parameters) are time-variant.
2. Numerical values of the parameters in the formula are revised (methodology is invariant).
   (a) Revision is scheduled at the time of project proposal;
      i. Revised numbers are specified;[3]
      ii. Revised numbers are not specified at the time of proposal;
   (b) Revision is unscheduled at the time of proposal.
3. Methodology applied is revised.
   (a) Revision is scheduled at the time of project proposal;
      i. Revised formula is specified, while the revised numbers are not;
      ii. Revised formula is unspecified at the time of proposal;
   (b) Revision is unscheduled at the time of proposal.

Using the mathematical formula, the baseline emissions $BE(t)$ is expressed as

$$BE(t) = f(p_1(t), p_2(t), p_3(t), \ldots): \quad \text{for Case 1 and 2;}$$

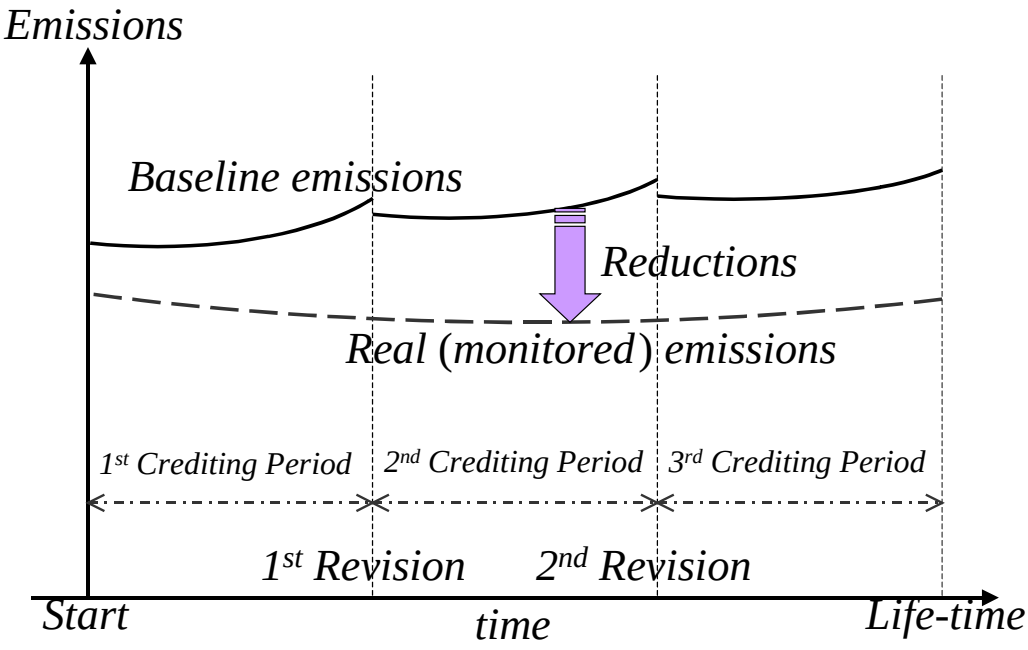
$$BE(t) = f(p_1(t), p_2(t), p_3(t), \ldots; t): \quad \text{for Case 3.}$$

Here $p_i(t)$ are (time-dependent) parameters which form the formula of the methodology. f is a function(al) of the parameter set p_i, which represents the concept of the methodology in a concrete manner.

Figure 1 shows an image of time-dependence of baseline (and project) emissions with the concept of crediting period, which is defined as a period during the revisions (and start or end) of the project. Figure 2 shows an image of methodological change of intensity (emission factor) at the time of 2nd revision.

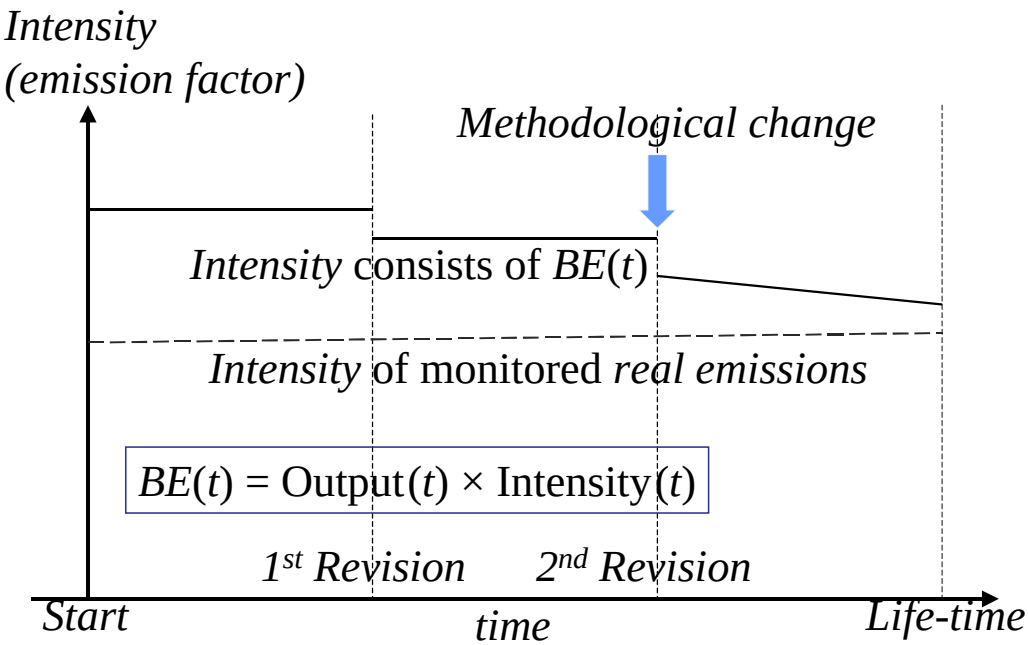
[3] The cases 2.(a) and 3.(a) i. can be categorized in the Case 1, mathematically.

Figure 1: An image of time-dependent baseline emissions



Baseline emission trajectory is generally time-dependent. The identical methodology is applied during the crediting period.

Figure 2: An image of revision of baseline methodology



This figure shows the intensity (emission factor) of baseline emissions. At the first revision, only a numerical value of intensity is revised. At the second revision, the methodology itself is also changed from time-independent intensity to a linearly decreasing one.

3. Baseline Setting in the Project Cycle

The procedure flow during the lifetime of the project comes under international negotiations. Although details are unclear at this time, we try to pick up the baseline-related procedures in the project cycle.

The procedures are categorized as before or during implementing the project, and for specified project or for institutional framework development. In this section, the former procedures are discussed

It should be noted that estimation process of emission reductions have two stages, *i.e.*, (ex-ante) expected reductions and (ex-post) achieved reductions.[4]

3.1. Before Implementation

3.1.1. Project Design/Proposal

At the time of project proposal, the participants may be required to identify the *expected* (or *anticipated*) reductions through the CDM project, in addition to other details of the project specifications. In other words, the participants should have forecasted emissions for the project case and also for baseline scenario.

The project participants search the standardized baseline methodologies specified in the CDM Reference Manual. If they can find an appropriate methodology for the project, they evaluate the baseline emissions applying the methodology with expected values of parameters (*e.g.*, output kWh).

3.1.2. Validation/Approval/Registration

After project proposal, it is validated by some institution (*e.g.*, by an Operational Entity). Such an institution reviews the appropriateness of the baseline methodology specified in the project proposal in the process of validation.[5]

In the project cycle process, approval by the Governments concerned and registration by the Executive Board comes before implementation of the project.

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[4] It should be noted that the discussions based on Activities Implemented Jointly (AIJ) experience often do not clarify this point. This is because AIJ has not yet full experience monitoring results. Analyses often target only the baseline setting at the time of proposal and often do not deal with the ex-post assessment.

[5] It is uncertain how deeply such institutions check the validity of the project, *e.g.*, technical and/or financial feasibility, sustainability requirement, or appropriateness of the numerical value used to calculate the expected baseline emissions.

3.2. During Implementation

3.2.1. Monitoring

Project participants monitor real emissions through the project year by year. In parallel, they reevaluate the baseline emissions applying the same methodology chosen at the time of proposal (and checked at the time of validation). Numerically, the reevaluated baseline emissions are not identical to expected baseline emissions with expected figures of parameters. This figure is used to calculate *achieved* (not expected) reductions.

3.2.2. Verification/Certification/Issuance of CERs

An Operational Entity checks this calculation in the verification/certification process in addition to monitoring project emissions. After verification of both project emissions and baseline emissions, the emission reductions are certified. Issuance of CERs by the Executive Board [or by COP(/MOP)] follows. This process continues at a regular interval (*e.g.*, annually) through to the end of crediting period.

3.2.3. Next Crediting Period

At the end of the crediting period, whether it is scheduled or not, the applied methodology is reviewed and may be changed in some cases. In the following crediting period, some new formula for baseline methodology and/or new procedures/methods for monitoring are applied.

4. Standardization of Baseline Methodology

4.1. Why Standardization is Needed?

Baseline standardization is standardization of baseline methodology, defined as applying the *same* methodology to *similar* type of projects".

Why standardization is needed? Quite simply, it would be strange to apply different methodologies to very similar projects. More practically, it would be costly for project participants if each project had its own tailor-made baseline methodology.

In sum, two reasons can be given for developing standardized methodology sets of baseline:

1. Ensuring the consistency of the scheme operation; and
2. Reducing the transaction costs.

For the second reason, which is often stressed, the scale of the transaction cost is comparable in scale with the implementation costs in the AIJ experiences. Moreover, CDM has a bigger handicap than emissions trading (Article 17) and joint implementation (Article 6) in terms of administrative costs. The development of the CDM scheme as a whole may be barred by setting a heavy burden on project implementers (*e.g.*, the case where the project developer is requested to establish the baseline methodology) and/or on the Executive Board (*e.g.*, if the Executive Board develops each baseline methodology specific to each project).

On the other hand, the first reason may be more important from the viewpoint of scheme operation. The consistency can be categorized as:

- The *credibility* of the CDM scheme may be reduced if the selection/application of baseline methodology for *similar* kind of projects are dependent on each Operational Entity;
- Cheating in credit generation for the CDM, since non-Annex I countries have no quantified targets, should be prevented;
- Uncertainties associated with determining the emission reductions should be managed.[6]

[6] The uncertainties mentioned here mean that baseline methodology and/or emissions may change by project or by time associated with baseline methodology setting and/or inconsistencies of applicable measurement guidelines. Standardization covering methodologies and measurement guidelines can remove these kinds of unnecessary uncertainties and inconsistency and insures the credibility of the whole scheme.

As shown in broad US experiences on emissions trading, a strong scheme framework is beneficial both to the environment and to utilization of the market. Standardization provides the scheme transparency and objectivity.

It should be noted that the complexity of the formula does not mean high transaction costs to apply the formula to calculate baseline emissions. Although a rather complex computer program represents the methodology, evaluation of the numerical value (baseline emissions) is straightforward. An important aspect of the methodology is that it be strictly and clearly defined.

4.2. Two Approaches for Standardization

We have two major approaches to standardize baseline methodologies. One is called *benchmarking* or *multi-project* approach. Another one is a *project-specific* approach. Let us see the characteristics of both approaches. It is sometimes misunderstood that a project-specific approach can only be applied to a very small category of project types, and that the benchmarking approach is much more broadly applicable and more a truly standardized approach. We should bear in mind, however, that the original concept of the baseline is project-specific and it can be applied to any type of project, while benchmarking can only be applied to some special types as a proxy of the project-specific one.

4.2.1. Benchmarking (Multi-Project) Approach

The benchmarking (or a multi-project) approach entails setting a reference intensity (emission factor or performance indicator), using a particular method. The applicable selection method, for example, averages over some category (*e.g.*, similar projects in similar development level countries or similar energy mix countries, ...) or selects some reference factor such as the best available technology.

As shown in figure 3, the emission reductions typically depend heavily on which concept is selected. It should be noted that *the benchmarking approach has **no** guiding principle to select the best (or better) concept.*[7]

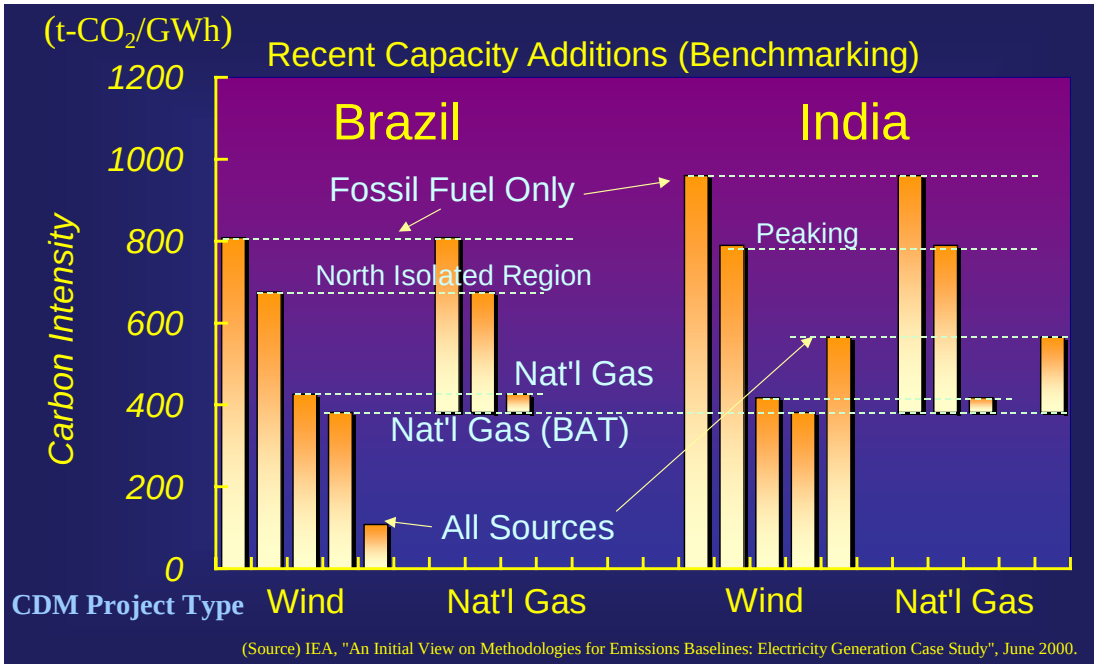
As for the transaction costs, *development* of the benchmarking formula for some type of project requires rather high cost, although *application* of the formula is much less costly. There are major ambiguities regarding which concept is to be selected. Some political or less than transparent considerations are expected to influence selection.

The benchmarking (multi-project) approach can be applied only to the project type whose baseline emissions can be divided into the product of emission factor and output. The applicable types of project are rather narrow due to the selection ambiguity typically

[7] On the other hand, the project-specific approach has the guiding principle to choose the more (most) probable scenario without the project, as shown in the following section. This guiding principle is only the definition of the baseline scenario.

shown in figure 3.

Figure 3: Possible benchmarking intensities in electricity generation project



There are varieties of options for selecting the concept of benchmarking intensity. This power plant construction project for wind or natural gas (in Brazil and India) shows that the selection of the concept results in major discrepancies when it comes to emission reductions achieved.

However, once some benchmarking method is developed for a type of project, like small renewable energy project disconnected to the grid, it can drastically reduce transaction costs for project participants.

In conclusion, the role of the benchmarking approach can be recognized as a proxy[8] of the project-specific approach for some typical and unambiguously defined type of project, especially for small projects.

4.2.2. Project-Specific Approach[9]

As mentioned before, the project-specific approach is the approach to realize the proper concept "most likely to occur without the project" of the baseline. This is a strong guiding principle to select the methodology to be applied. Sometimes, this approach is seen as the opposite concept of standardization of baseline methodology. For sufficiently *similar* projects, however, it is reasonable to apply the *same* methodology. In other words, *similarity* of the project is defined so as to apply the *same*

[8] In other words, benchmarking baselines should be conservative as better-than-average, incorporating some indirect (leakage/spill-over) effects of the project and some correction factor.

[9] N. Matsuo, "Proposal for Step-by-Step Baseline Standardization for CDM—From Project-Specific to Generalized Formula (version 2)", IGES Discussion Paper, January 2000.

methodology even in the case of a project-specific approach.

The process to generalize baseline methodology from a specific case is conceptually as follows:

Step 1

First, the (ad-hoc) Executive Board prepares/develops an initial standardized set of methodologies for typical types of existing AIJ (and expected CDM) projects using the generalization method starting from some specific cases.

Step 2

Once a project is proposed, use an existing standardized methodology specified in the CDM Reference Manual to estimate the projected baseline emissions if applicable. If not applicable, check the availability of generalization of an existing methodology. Generalization includes expanding the applicable range of parameters and introducing new parameters. If both are judged to be inappropriate, develop an independent new methodology specific to the project.

Step 3

The Executive Board reviews the adequacy of each baseline methodology and revises it at regular intervals if necessary. However, once a methodology is applied to a project, it should be valid throughout the crediting period of the project, independent of whether or not the methodology is altered by the Executive Board.

Box (System Boundary)

The *system boundary* specifies the influenced area of the project. Reductions are defined by baseline emissions minus real emissions within the boundary. It is categorized into (1) technical boundary and (2) socio-economic boundary. The latter, including indirect effects, is rather difficult to estimate with sufficiently acceptable manner.

If the baseline scenario is that the other firms/plants compensate the production of the CDM project in the absence of the project (like case study shown in this paper), the technical boundary can be selected as the country as a whole (or grid connected to the project as a whole).

The concept of system boundary is connected to the “most probable” principle, so it can only be applied to project-specific approach naïvely. In other words, system boundary concept can be incorporated to the selection of an intensity in the case of benchmarking approach *implicitly*.

Now let us consider a typical example of new fossil fuel thermal power plant construction case.[10] In this example, here we set the methodology for baseline emissions:

(Baseline emissions (t-CO_2/yr))
= (Mean CO_2 intensity of the thermal power plants in the country (t-CO_2/kWh))
× (Power generation by the project (kWh/yr))

as a simple starting point (the "mean" does not include the project concerned). In this case, "use of mean CO_2 intensity of the thermal power plants in the country" implies that we use the baseline scenario as "the scenario where other thermal power plants in the country increase their rate of operation uniformly to compensate the electricity generation by the CDM project" and we judged this scenario as most appropriate one to describe the situation. This methodology is more meaningful as a way to describe the scenario than using a simple average as in the benchmarking (multi-project) approaches, although the method is otherwise identical.

Can this methodology be applied or generalized to 'similar' projects? In the case mentioned above, we make certain implicit assumptions, such as:

1. Connection to the power network system;
2. Limited scale of the project in comparison to the capacity of the whole network;
3. Electricity is the only output; and
4. No power development plan, which the project replaces.

An example of generalization to a broader category of projects not limited to the above constraints is shown in figure 4. This flow chart is only the generalized (standardized) set of baseline methodologies for electricity generation type projects.

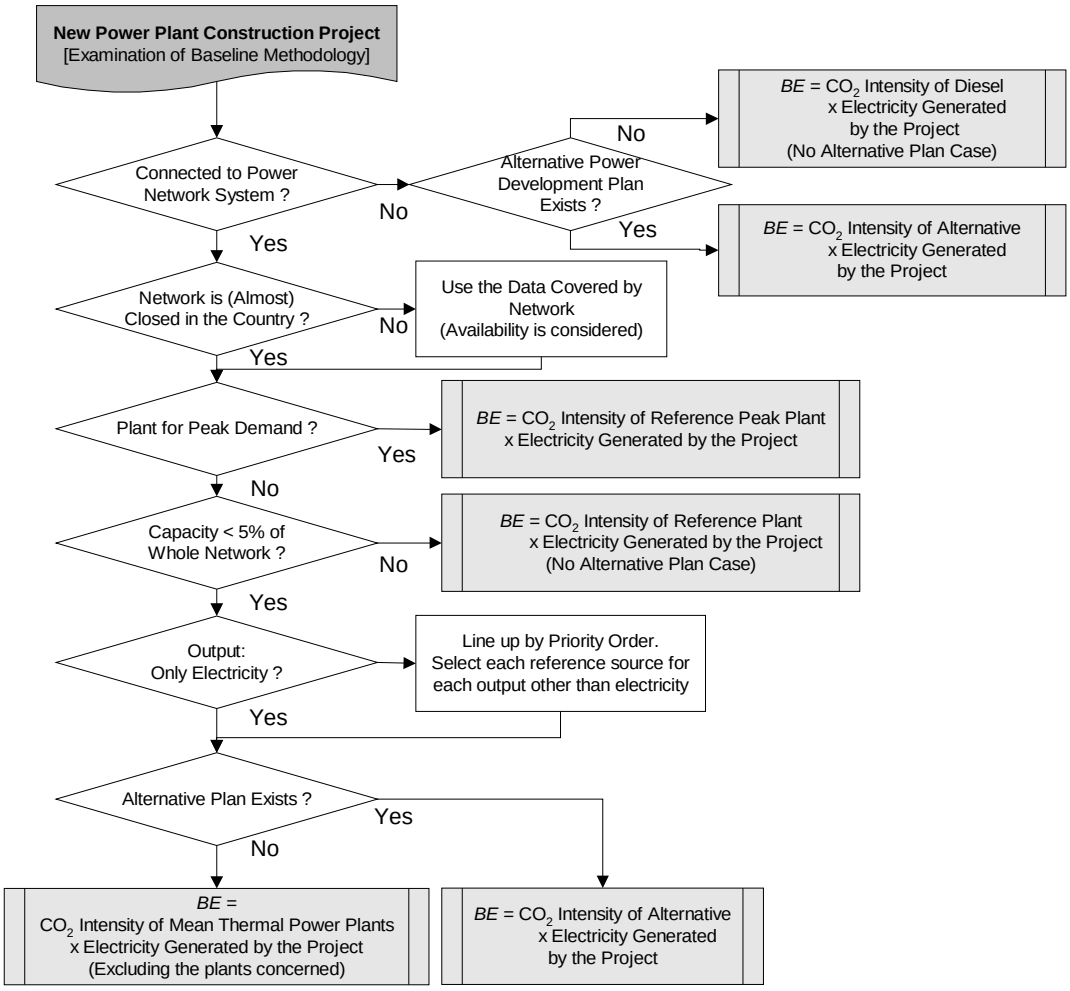
4.2.3. CDM Reference Manual

Regardless of the approach, it is unrealistic to prepare a complete set of standardized methodologies for all project types. In order to develop the scheme step by step, a concept of "CDM Reference Manual" is proposed by several countries as a standard setter for all CDM rules and procedures including baseline methodologies.

The reference manual may contain (1) decisions of COP/MOP, (2) standards for accreditation of Operational Entities, (3) approved baseline methodologies, (4) guidelines for monitoring, verification and certification, (5) reporting formats and guidelines, and so on. The Executive Board is expected to make it available on the Internet.

[10] Following the principle: "most probable without the project", it can be said that there is no conceptual difference between a retrofit type project and a greenfield type project. The purely retrofit type with the same production is continuously connected to the greenfield type through the retrofit with increased capacity type.

Figure 4: Step-by-step standardization decision tree for power generation projects

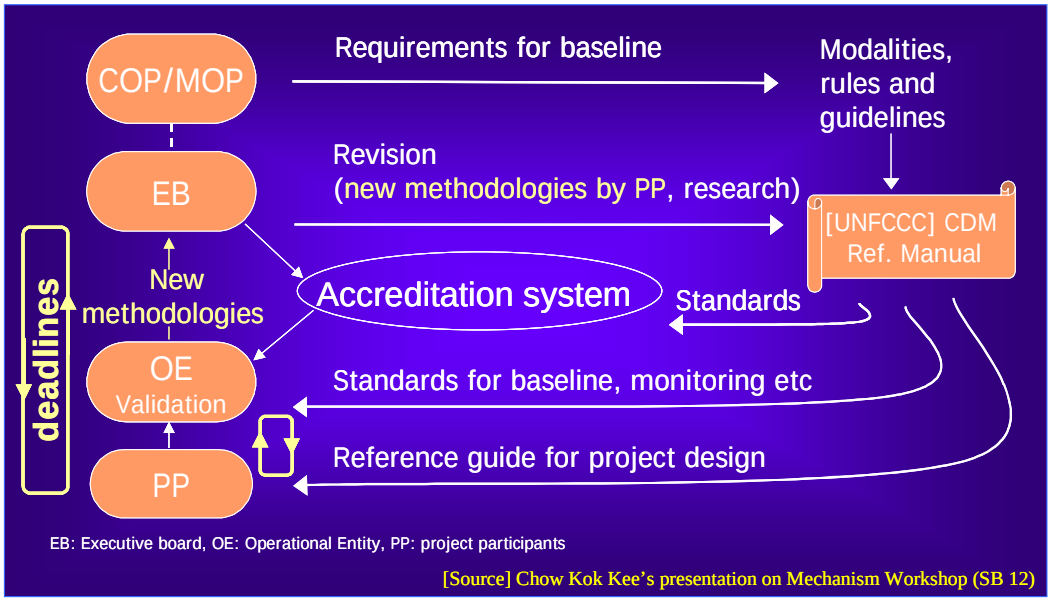


The Reference Manual is the *living* document, which is regularly updated (without retroactive application). In the context of baseline methodologies development, an image of the procedures is shown in figure 5. Following is an image of the role of the Manual.

The CDM Reference Manual provides a reference guide for project design and baseline methodology standardization to the project participants and Operational Entities. An initial set of standardized methodologies may be requested by the COP/MOP to be on the Manual as a starting point. Once a new baseline methodology for some case is proposed by the project participants, and/or Operational Entities, (and/or expert committee); the Executive Board reviews it and revises the reference manual incorporating such new methodologies after investigation.

Whether or not the contents of the baseline methodologies specified in the manual are rigidly applied or a simple compilation of good practices will be negotiated

Figure 5: Baseline methodologies development and the CDM Reference Manual



In any case, some step-by-step development to prepare the baseline methodologies is necessary for participants. Designing the CDM framework to be rigid (less risky) and less costly is the key issue to promote development of CDM in the future.