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Proposal for Step-by-Step Baseline Standardization for CDM

— From Project-Specific to Generalized Formula —

Version 3

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Abstract

Baseline setting is a key step in the process to identify certified emission reductions for CDM. This paper clarifies some 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 also 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.

These conclude the necessity of the baseline methodology standardization (generalization) from project-specific cases. With a typical example of the standardization process, this paper demonstrates the flow of the standardization process clarifying the guiding principle of "most probable without the project", excluding the (political) ambiguities.

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1. Introduction

1.1. Background

Despite the eminence of its start-up in the year 2000, Clean Development Mechanism (CDM) still embraces the issue of "how to set up baseline methodologies" as a remaining issue in its essential technicality with no prospect of resolution in sight. Baseline is to become a reference scenario for credit evaluation, yet there still remain many unresolved technical problems that need to be resolved in the actual *operation* of the scheme.

Concerning this baseline issue, the importance of *standardization* has been indicated, while consideration for project-specific approach has been sought necessary. Generally, in a systematic and structural approach for the Kyoto Mechanisms such as CDM, it will not be practical to prepare a complete and flawless system from the start. In other words, the designing of the mechanisms requires system designing toward *currently* targeted COP 6, based on "step-by-step" and "learning-by-doing" evolution.

First, 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. Secondly, it proposes "an approach to address baseline *standardization* problems by starting up from the project-specific case to the generalized methodology set". This technical proposal, however, is not for a standardized baseline methodology covering each project type. Rather, it is a proposal for how to establish and evolve such methodology step-by-step. In this paper, the other items such as (finance-related) *additionality* required for system design are not discussed directly, in principle.

1.2. Structure of the Paper

The rest of this section is devoted to the definition of baseline itself and baseline-related terminology in addition to the clarification of the time-dependence. 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. The procedures of project-cycle are also depicted here. Section 2 focuses on why the baseline methodology should be standardized. 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. Relationship between project-specific and benchmark approaches is clarified in section 3, with clear understanding of the benchmarking approach. A proposal for establishing evolving standardization methodology is provided in section 4, followed by a case study of electricity generation greenfield project in section 5, and prospects in section 6.

1.3. What is "Baseline"?

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

> Emission reductions resulting from each project activity shall be certified …, on the basis of: … (c) *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 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' or 'accurate' baseline emissions. Baseline setting is 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 ('real' world) (*e.g.*, output kWh of the project) are used to calculate baseline emissions which are emissions in the counterfactual 'parallel world'.

1.4. Terminology related to "Baseline"

In the discussion of CDM scheme, especially for baseline issues, much confusion arises from the unclear and ambiguous usage of terminology.[1] Misunderstanding from difference in terminology and its interpretation often leads to the breakdown of arguments. This paper uses the terminology based on the following definitions:

- **Baseline**:

  This term will not be used as a common noun. Exception is the case of usage as "a general concept (equivalent to baseline scenario)" in reference to a project, where no room for misunderstanding. Otherwise, "baseline" will be used as an adjective, like "baseline emissions" or "baseline methodology."

- **Baseline emissions**:

  Baseline emissions $BE(t)$ are an emission trajectory from which the *net* emissions of each project are to be subtracted in order to calculate *emission reductions*. 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 (emission factor). In this example, output (*e.g.*, kWh/year) and intensity (*e.g.*, ton-CO_2(*eq*.)/kWh) are both time-dependent parameters, in general. The output is an *external* factor set to be equivalent to the project output; however, we do not differentiate the parameters in relation to attributes concerned.[2] The baseline emissions

[1] Sometimes, the terminology is inconsistently used even in one paper.

[2] 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 nothing but the *revision* of the baseline methodology. See "Revision of baseline".

are the quantity from which to derive emission reductions. In other words, baseline determination is to determine baseline *emissions*. It can be misleading to use the single word "baseline", which sometimes intends to mean "emission intensity (emission factor)" or "baseline scenario (case)".

- **Baseline approach**:

  Here we define the word "approach" for "project-specific approach" and "benchmarking (or multi-project) approach". The word "methodology" is used for those within each approach. The role of benchmarking approach is described in section 3.

- **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 a form of a flow chart (or decision tree) including various *characterizations* (*branchings*).[3] 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* (*concept*) for some type of projects, *not* harmonizing the baseline emission intensity or the emissions themselves. "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.

1.5. Time-dependence

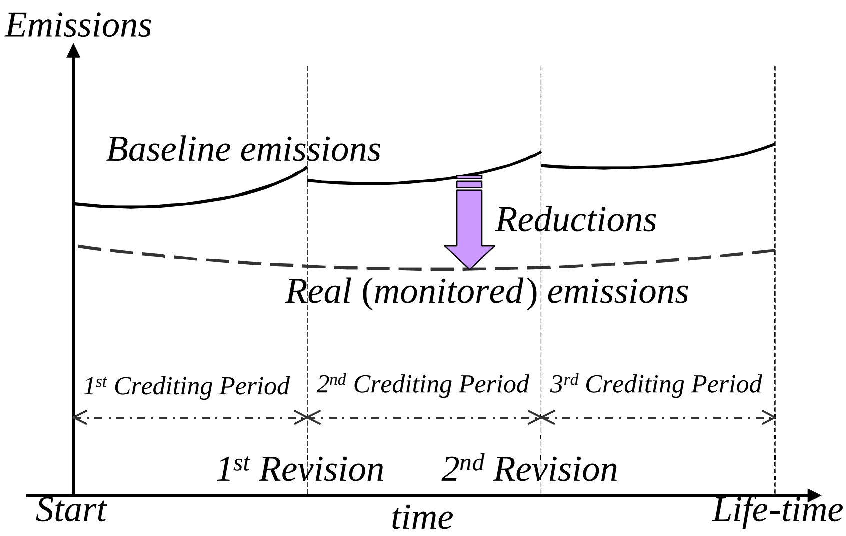
It is confusing to use the terminology *static* or *dynamic* to characterize the time-dependence of the baseline methodology and/or baseline emissions. For example, sometimes the concept "static baseline" is used for (1) time-independence of baseline *emissions*, (2) time-independence of a baseline *emission 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 (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

[3] See figure 8 for a typical image of a standardized methodology set.

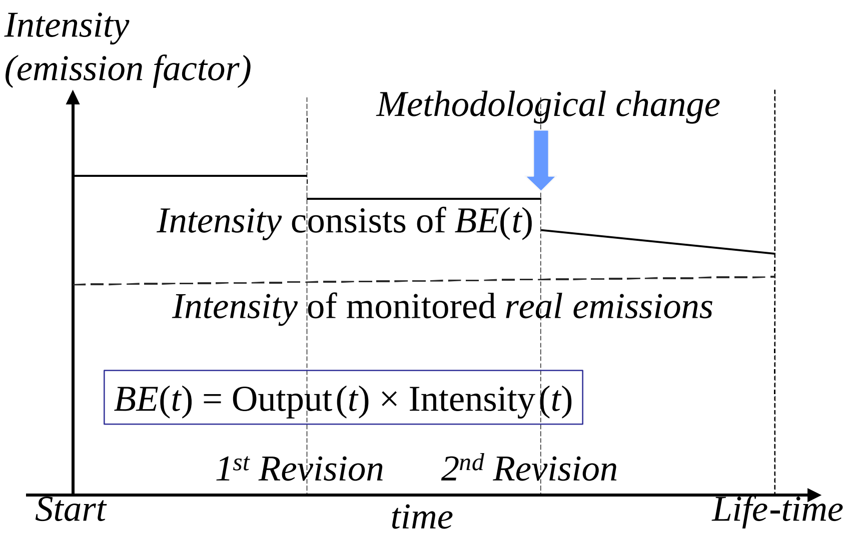
whether or not the application is retroactive.[4] In this paper, the term "crediting period" is used between (some kind of) revisions (or starting/ending point). The whole lifetime of the project consists of several crediting periods. See figure 1 and 2 for images.

Figure 1: An image of time-dependent baseline emissions



[Note] 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



[Note] 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 (in general, intensity itself is (non-linearly) time-dependent).

[4] Revision of the methodology may increase the risk for investors and reduce the credibility of the scheme, especially for unscheduled revisions. In other words, even in the case that the methodology is revised in the middle, the identical methodology should be applied throughout the project lifetime after the initial estimation of the expected baseline emissions.

The concept of time-dependence (including revision) 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 is invariant, while output is time-variant (if baseline emissions are expressed as output times intensity);
    (b) Both intensity and output are time-variant.
2. Numbers 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;[5]
        ii. Revised numbers are not specified at the time of proposal;
    (b) Revision is not scheduled at the time of proposal.
3. Methodology 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 not specified at the time of proposal;
    (b) Revision is not scheduled 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 represent the concept of the methodology in a concrete manner.

1.6. 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 of a CDM project.

It should be noted that estimation process of emission reductions have two stages, *i.e.*, (ex-ante) *expected* reductions and (ex-post) *achieved* reductions as shown in Figure 3.[6] Emission reductions can only be settled (annually) after implementation of the project. The

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

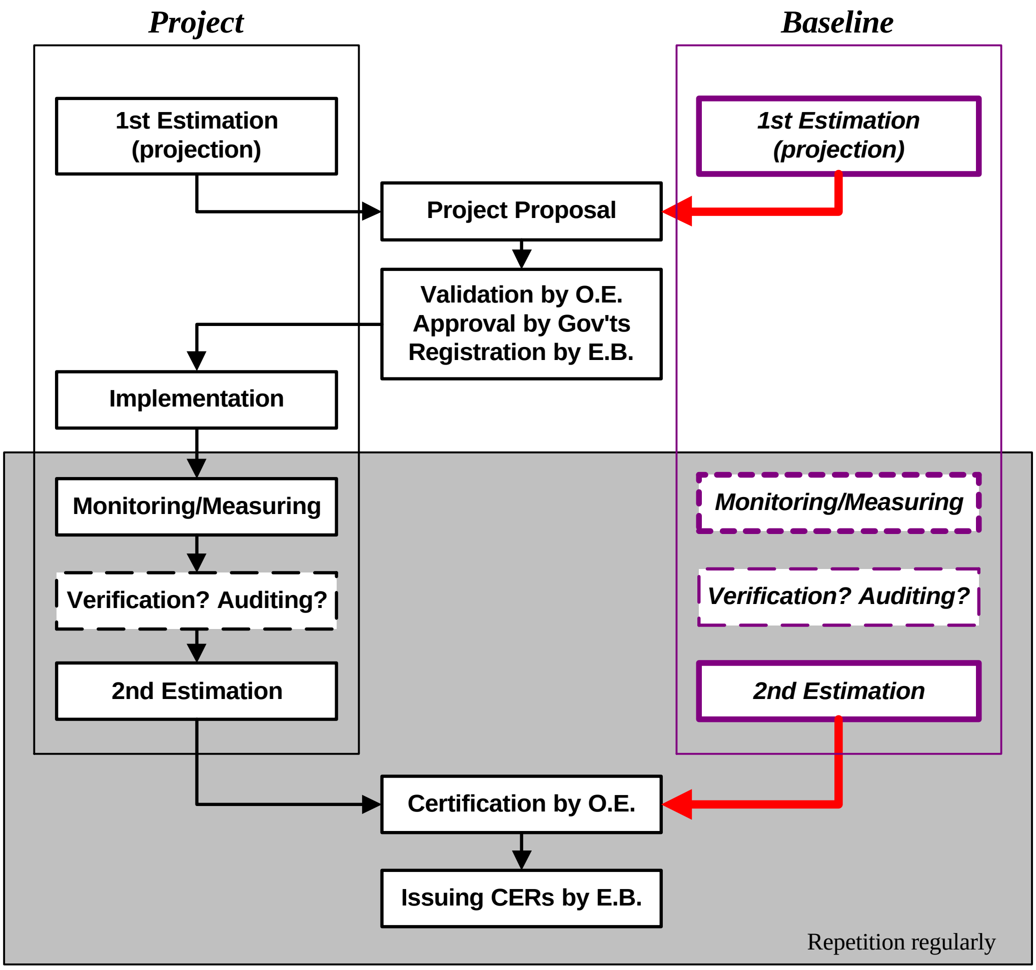
[6] It should be noted that the discussions based on Activities Implemented Jointly (AIJ) experiences often do not clarify this point. This is because AIJ has not yet full experienced monitoring results. Analyses often target only the baseline setting at the time of proposal (expected/forecasted baseline)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

emissions by the project could be determined only after the (regular) monitoring of emissions.[7] Therefore, it is natural to set the scheme that the baseline emissions are also determined by *ex-post* basis. For example, if we *define* the baseline emissions for the construction of new power plant as:

(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)),

the electricity generation is only determined *ex-post* (also for the intensity).[8]

Figure 3: Outline of the Baseline estimation in the CDM project-cycle



[Note] There are two series whose emissions are monitored (or calculated). One is the scenario of the project itself in the real world, and another is that of baseline in the counterfactual world. Annual baseline emissions are estimated twice, *i.e.*, ex-ante (projected/expected baseline emissions) and ex-post (achieved) implementation of the project.

[7] It is possible to have a business contract (independent of Kyoto Protocol) *in advance* to transfer the reductions expected in the beginning. In this case, if the reductions are proved not to be enough *after* implementation, the contractor must raise the CERs (or AAUs) in the emissions market in order to fill the shortage.

[8] In this case, the parameters in the formula of baseline emissions are two; both of them are time-dependent (running/rolling parameters).

In the flow of procedures (project-cycle) of CDM, annual baseline emissions are estimated twice, *i.e.*, *ex-ante* and *ex-post* of project implementation (it might be better to use the word "evaluate" for the Step 2):

Step 1. *Ex-ante* estimation: at the time of proposal (only once);

Step 2. *Ex-post* evaluation: at the time of estimating (or verifying/certifying) reductions (annually).

The terminology "*expected* emission reductions" and "*achieved* emission reductions" is used for each step. In the Step 2, the parameters in the baseline methodology applied should be time-dependent in general. Equivalently, the baseline emissions are calculated using only the parameters in the past, not forecasted parameters.

In the following explanation, we assume that the Ad-Hoc CDM scheme can start after the decisions of COP 6.[9]

Before Implementation

Project design/proposal

At the time of project proposal, the participants may be required to estimate the *expected* (or *anticipated*) reductions through the CDM project, in addition to identification of 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 (described later). 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).

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.[10]

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

During Implementation

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

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[9] Such Ad-Hoc base CDM scheme governed by COP (*not* COP/MOP) is strategically very important in the future development of the international climate regime. This scheme can continue/develop *without* entry into force of the Kyoto Protocol which is deeply influenced by the ratification by the US Senate.

[10] 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.

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.

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 (certified emission reductions) by the Executive Board [or by COP(/MOP)] follows. This process continues at a regular interval (*e.g.*, annually) through to the end of the crediting period.

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 judged to be appropriate to do so. In the following crediting period, some new formula for baseline methodology and/or new procedures/methods for monitoring are applied.

2. Needs for Baseline Standardization

2.1. Essence of the Baseline issue

Is it possible to estimate the baseline emissions to any level of accuracy? The answer is impossible, in principle. The baseline emissions are *defined* as "the emissions that would occur in the absence of the project" as discussed before. This implies that the baseline emissions are those of counterfactual state, which cannot be measured in principle. It is meaningless to seek a final solution to the *accurate* and *observable* baseline emissions. In other words, the problem is how to *define*/*select* the baseline scenario.

On the other hand, it is against the spirit of the Protocol[11] in the case when the emissions of defined baseline scenario are apparently more than those of scenario that is most likely to occur, in addition to the difficulty in international negotiations to accept. We have this kind of concern when trying to take into account the project-specific factors, especially.

It can be concluded that the baseline issue is identified as how to establish a process to define the baseline scenario, which can be regarded as most likely to occur by everybody.

2.2. Why "standardization" is needed?

Baseline standardization is standardization of baseline methodology, defined as applying the *same* methodology to *similar* type of projects. Now let us consider whether we should have standardized methodology for calculation of baseline emissions. 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 should have its own tailor-made baseline methodology. In sum, two positive reasons can be seen for developing standardized methodology sets of baseline considering the fact that the baseline emissions are *counterfactual* in nature:

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

[11] On one hand, Kyoto Protocol may not claim that the global emissions are *reduced* explicitly by implementing the CDM project. The CERs are nothing but the transfer of reductions in a host non-Annex I country to an investor Annex I country as a zero-sum game. On the other hand, we can expect *additional* reductions in the host country in future through the indirect spillover effects such as technology transfer associated with the CDM projects. The author's opinion for designing the scheme is not whether, but how to design to maximize such indirect effects.

handicap than emissions trading (Article 17) and joint implementation (Article 6) in terms of administrative expenses. 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 the *similar* kind of projects are dependent on each Operational Entity. The methodology may differ project by project although they are the *same* type;[12]
- Cheating in credit generation for the CDM, since non-Annex I countries have no quantified targets, should be prevented;[13]
- Uncertainties associated with determining the emission reductions should be managed.[14]

As shown in broad US experiences on several emissions trading schemes, a strong and stringent 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 of the baseline methodology 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 and almost costless. An important aspect of the methodology is that it be strictly and clearly defined.

We should establish a firm scheme, which is the basis to utilize market mechanism, with little ambiguity anyhow. Standardization, especially for baseline methodology, might be inevitable and necessary to ensure the objectivity and transparency of the scheme.[15]

[12] We may set a rule to rate values of individual credits specific for (type and/or certifier of) project (through the market). In this case, there are heterogeneous commodities in the CDM emissions market. The author expects that this rule may become a barrier for development of the CDM emissions market due to the higher risk associated with its complex structure.

[13] CDM has tendency that both investors and hosts overestimate the baseline emissions and thus reductions (credits). This comes from the fact the host non-Annex I country does not have quantified target, not the case for JI (Article 6).

[14] 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 kind of unnecessary uncertainties and inconsistency and insures the credibility of whole scheme.

[15] In addition, it may be desirable to set up another standardization for measurement of real emissions by the project. The good practice methodologies in the improvement process of IPCC GHGs inventory guidelines (http://www.ipcc-nggip.iges.or.jp/gp/report.htm) can be applicable in some cases.

2.3. 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.

It is sometimes misunderstood that:

- the standardization is equivalent to benchmarking;
- the 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 and can be standardized, while benchmarking is only applied to some special types as a proxy of the project-specific one.

In the following section, we see what the benchmarking is and how to understand such approach.

3. Role of Benchmarking Approach

3.1. What is benchmarking (multi-project) approach?

Benchmarking (multi-project) approach is a standardization approach to define the (physical) performance (intensity) of baseline scenario by setting some "reference performance" using some methodology.[16] A kind of averaging/aggregation[17] is expected to be used to establish such reference performance in many cases. The applicable calculating method, for example, averages over some category (*e.g*., similar projects in the host country, similar development level countries or similar energy mix countries, ...), or selects some reference emission factor such as that of the best available technology matrix.

However, as mentioned in section 2, the baseline scenario is *defined* as the most probable scenario in the absence of the project. In other words, the baseline emissions should be calculated by a tailored method based on the consideration of project specific conditions (project-specific approach). So, it is not clear why and how we use the benchmarking approach referring to this definition of the baseline scenario.

3.2. Ambiguity in selecting reference performance

The biggest and fatal disease of the benchmarking approach is the lack of guiding principle in selecting reference performance.

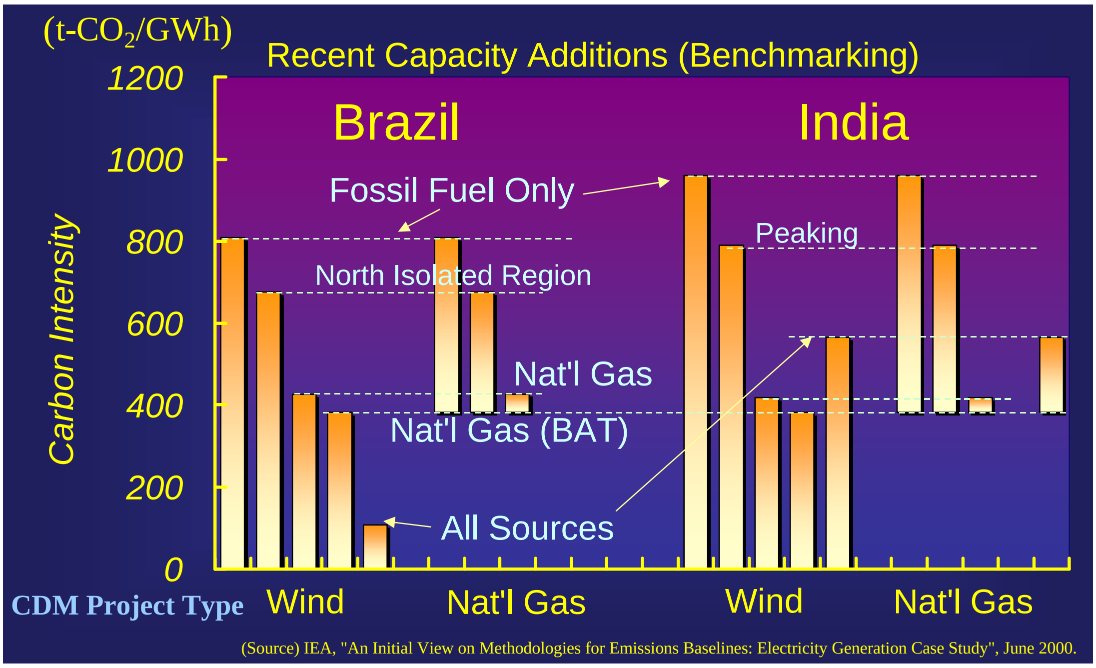
Figure 4 shows a variety of possible reference carbon intensities of wind and natural gas fired electricity generation project in Brazil and India. The resulting emission reductions depend very much on the selection of the reference performance. For example, in case of wind power plant in Brazil, the reductions obtained for reference performance of fossil fuel power plant average are around 8 times bigger than those of all power plant average, as Brazil is hydro rich. In case of natural gas fired plant, the reductions are negative if we select all source average as the reference.

This is very important in operation of the CDM scheme. If the project participants can choose the reference benchmark, they tend to select higher one. On the other hand, if the Executive Board set a rule to choose one reference benchmark for a type of project like wind power generation, it should be applicable for Brazil and India. It is difficult to set uniform reference benchmarking performance, in general.

[16] This definition includes so-called technology-matrix and macro- baseline approaches.

[17] Similar (or the same) averaging/aggregation may be used both in benchmarking and in project specific approaches. However, those two are *completely different* as the latter tries to realize the most probable scenario, on the other hand, the former has no such guiding principle.

Figure 4: Possible benchmarking performances in electricity generation project



[Note] There are varieties of options for selecting the concept of benchmarking reference performances. 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 obtained.

On the other hand, such selection of benchmarking performance may influence the estimation of the potential reductions in the CDM projects from supply side.[18] No macroscopic estimation of the potential of CDM deals with this kind of ambiguity into consideration, although such selection may affect several times in estimating the potential.

All of those ambiguities come from the *lack* of guiding principle to select the best (or better) concept (not number) of benchmarking performance.

3.3. How to understand the benchmarking approach

The benchmarking approach can be recognized as a *proxy* of the project-specific baseline approach, which is difficult to apply due to its high transaction costs and/or technical difficulty.[19] In other words, it is the second-best approach which tries to define *conservative* baseline emissions using some better-than-average concept.

The benchmarking approach cannot be applied to all types of project, but to some relatively unambiguous types. However, as it has no technical guiding principle “most likely to occur”, it is ambiguous which methodology (including the averaging category) to be chosen. In other

[18] The potential of CDM can be estimated from demand-side as well. The potential is expressed as the BaU (current policy) projection minus the effects of *additional* domestic policies and measures with IET and JI to be implemented within Annex I countries minus Annex I target emissions specified in the Kyoto Protocol.

[19] However, there is no evidence that the benchmarking approach is less costly in developing the appropriate methodology than project-specific approach (private communication with Mr. Jed Jones).

words, some political or less than transparent considerations are expected to influence the selection.

It is meaningless to take tailored specific character of the project into consideration in the benchmarking approach. The role of the benchmarking approach is to establish/define a simple but conservative methodology that might include the indirect (leakage/spill-over) effects.

The benchmarking approach can be appropriate for the small renewable type projects, like PV or micro-hydro isolated from power supply network. In these cases, the most probable scenario without the project might be nothing-happened case. However, if we take the sustainability objective of the CDM seriously, it can be reasonable to set the baseline scenario to be diesel power generation as the benchmark politically. Moreover, these small local-based projects can be promoted by preparing typical benchmarking methods avoiding high transaction costs that are relatively high for those projects.

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 shown in figure 4.

This may lead to the conclusion that selection method between coexisting project-specific and benchmarking approaches might be realistic way.

While the transaction costs to *develop* the benchmarking formula for some type of project may be rather high, although *application* of the formula is much less costly.[20]

However, for the projects appropriate for the benchmarking use are also expected to be easy to establish project-specific baseline methodologies. As the benchmarking approach tends to be conservative, it is expected to shift from benchmarking to project-specific as the latter compile the cases to gradually standardized one as discussed in the following section. So, benchmarking might be transitional approach to the standardized (generalized) project-specific approach.

[20] Less cost in application and higher cost in formula development are the characteristics of the “standardization” in genetral, not specific to the benchmarking approach.

4. Proposal for Standardization Approach

4.1. Concept

As mentioned earlier, importance of the standardization is stressed for the baseline setting on one hand, project-specific considerations are regarded as important as well on the other hand. It seems necessary that the baseline methodology incorporating specific factors of each project can be developed if we attain greater importance on "most likely to occur" nature of the baseline scenario. 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 methodology even in the case of a project-specific approach.

This paper proposes an approach to standardize the baseline methodology step-by-step incorporating the project-specific factors as much as possible. It should be clarified that "standardization" and "simplicity" are different in concept.

The guiding procedure is a sort of inductive approach:

- Starting from a specific project case;
- This specific case is generalized through a certain procedures;
- The methodology will cover the wider range of projects step-by-step.

This process is similar to that of forming common laws.

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

1. First, a baseline methodology for one specific project proposed is determined using some method considering the criterion "*most likely to occur* in the absence of the project". The formula of this methodology consists of some parameters. The applicable range of the parameters is the only one point at this level of the process;[21]
2. Next, try to expand the applicable range of parameters for the methodology considering the criterion "most likely to occur".[22] This is nothing but the definition of *similarity* that the *same* methodology can be applicable.
3. If a project, which seems to be similar but cannot be covered by existing method-

[21] In other words, the methodology is valid only at one point in the parametric space.

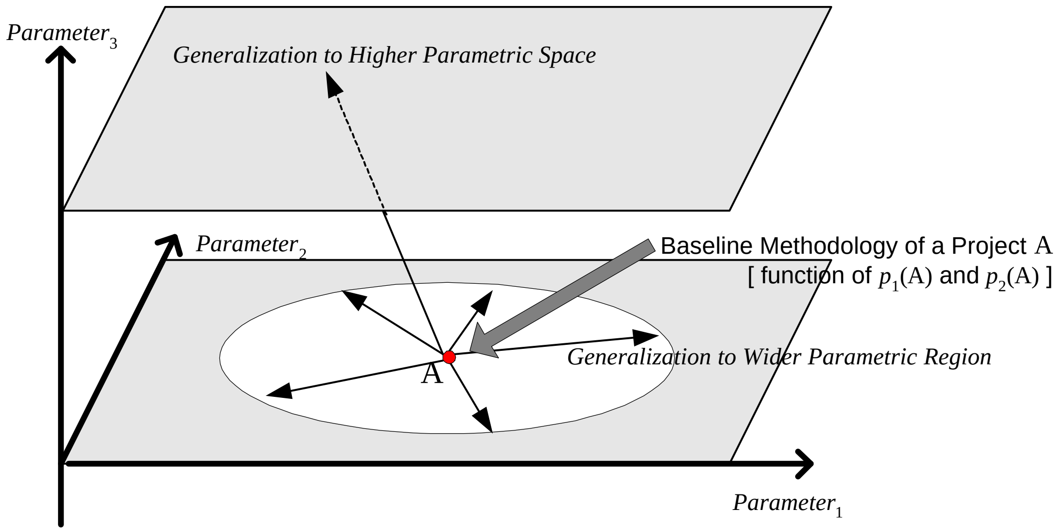
[22] This means that the applicable one point is expanded to a region with finite volume in the parametric space (see figure 5).

ologies, is proposed, try to generalize the methodology by increasing the number of parameter set, considering the criterion "most likely to occur". This generalized methodology covers the former one as (a) special case(s).[23]

4. The steps mentioned above can form a generalized *set* of methodologies. This is the standardized methodology set evolved proposed in the paper.

In this standardization process, it is desirable to specify the applicable source and measurement guidelines of data consisting of the methodology formula in order to manage the uncertainties.[24]

Figure 5: Baseline methodology: Concept of generalization in the parametric space



4.2. Approach

Here we see the actual step-by-step evolutionally process concerning the baseline methodology setting based on the proposal of the paper.

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.

Here we assume that the entity that deals with the process is the Baseline Technical Committee

[23] This means to expand the dimensions of the parametric space and also those of applicable area (see Figure 5).

[24] For example, the rules like following are envisaged: "For this parameter, use the data in the annual report of the utility company A. If not available, calculate the parameter using the data in the IEA Energy Statistics of Non-OECD Countries annually".

to be established under the Ad-Hoc Executive Board (AHEB).[25] The AHEB is responsible for the decisions concerned.

Step 2

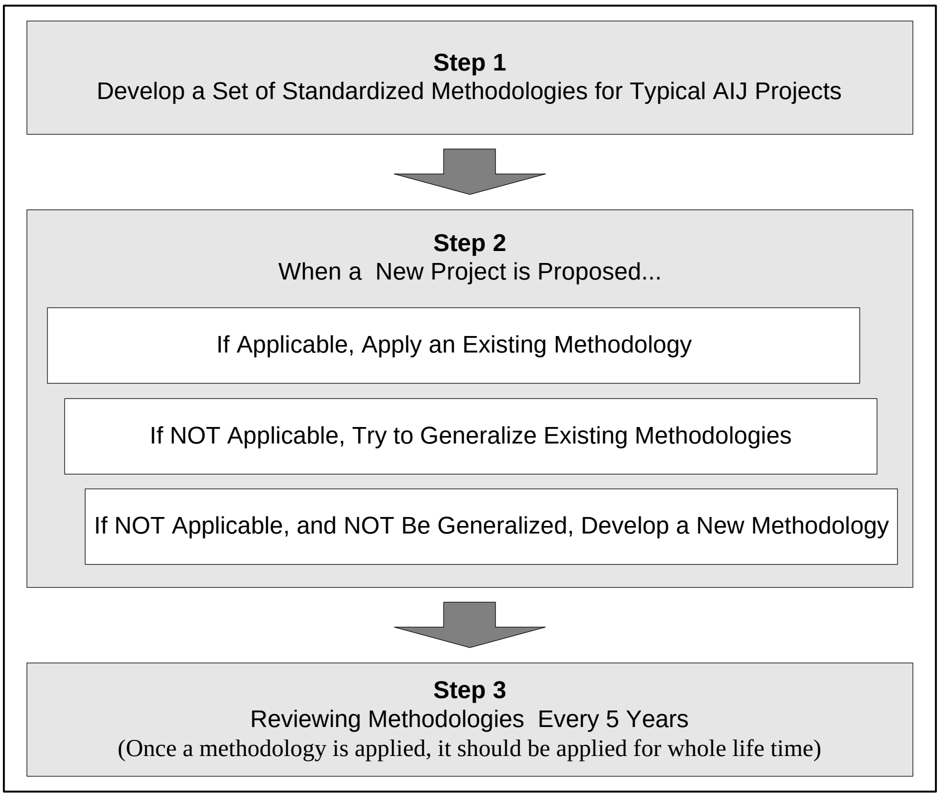
Once a project is proposed, an existing standardized methodology to estimate the projected baseline emissions is used if judged to be applicable. If not applicable, checking the availability of generalization of an existing methodology follows. Generalization includes expanding the applicable range of parameters and introducing new parameters. If both are judged to be inappropriate, an independent new methodology specific to the project will be developed. The Baseline Technical Committee operates this process and AHEB makes decisions.

Step 3

The Baseline Technical Committee reviews the adequacy of each baseline methodology and revises it every five years if necessary. AHEB is responsible for the decision.

However, once a methodology is applied to a project, it should be valid throughout the crediting period of the project, independent of the case whether the methodology was changed or not by the AHEB.

Figure 6: Phased development of standardized baseline methodology



[25] The Executive Board will be established as a supervising body for CDM. Here we assume that the ad-hoc body will be established under the Convention to play the similar role of the Board, until the entry into force of

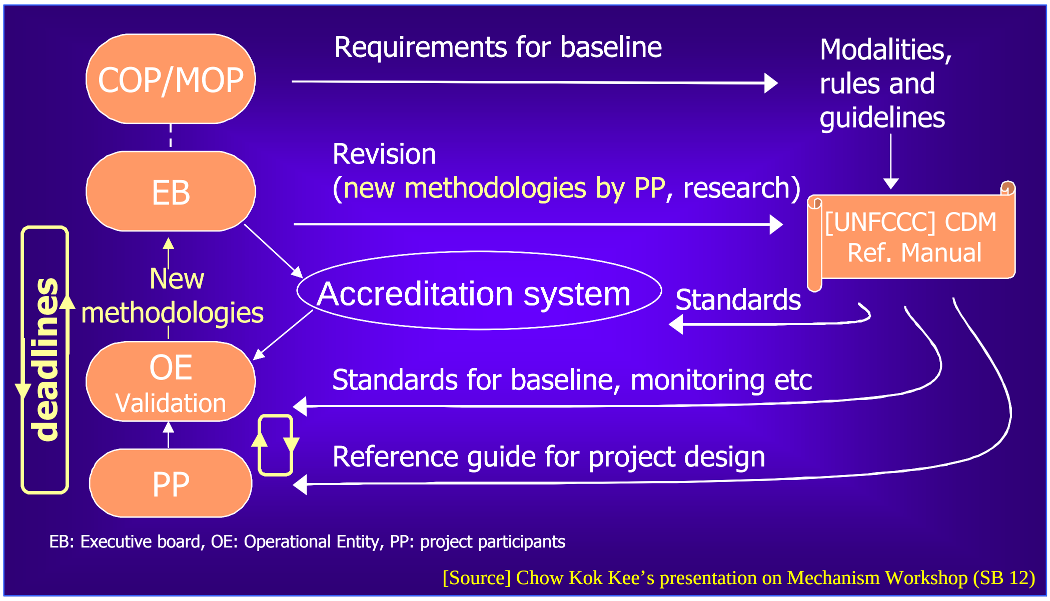
4.3. CDM Reference Manual

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.

The Reference Manual is the living/evolving document, which is regularly updated (without retroactive application). In the context of baseline methodologies development, an image of the procedures is shown in figure 7. Following is an image of the role of the Manual.

Figure 7: Baseline methodologies development and the CDM Reference 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 technical 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 toward and beyond COP 6

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the Protocol.

in den Hague.

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.

5. Case Study Simulation

5.1. Setting Baseline methodology for simple case

Here we simulate the way of thinking mentioned above applying the approach to a simple case of “new fossil fuel thermal power plant construction”. The explicit methodologies used here are only for explanation use. We do not insist that the methodology mentioned here is the best one.

The methodology to calculate the baseline emissions should pay attention to the guiding principle “most likely to occur” in the absence of the project. It is important to develop and define the methodology that describes the *acceptable* scenario.

Following this principle, it can be said that there are no conceptual difference between retrofit type project and greenfield type project.[26] Pure retrofit type with the same production is continuously connected to the greenfield type through the retrofit with increased capacity type. The appropriate system boundary of those projects might be the region with invariant demand of the output with and without the project.[27] Let us see the electricity generation case for greenfield project case (new fossil fuel thermal power plant construction). Application to retrofit-type is straightforward.

In this case study, here we set the methodology for baseline emissions as:

(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 (“mean” does not include the project concerned). In this case, “usage 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 has deeper meaning to describe the scenario than simple averaging method. In this case, it should be noted that the system boundary is the power network system as a whole, not limited to the possible alternative baseline project.[28]

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[26] In many cases, the retrofit and greenfield type projects are separately treated. Especially for the greenfield type project, some argues marginal or average efficiency project as the alternative of the project. However, in the real world, it is difficult to image that such kind of marginal or average efficiency project will be implemented instead, but no alternative project will be implemented. In this case, some other related existing facilities will meet the (incremental) demand equivalent to the project output.

[27] For retrofit with the same capacity (strictly, same production) case, the system boundary can be *equivalently* reduced to the site only. See Annex for the proof.

[28] System boundary might be better to be common throughout the generalized set of methodologies.

The reason why we limit thermal power plants in the whole network is as follows. For the renewable energy power plants such as hydro and wind, the generation is determined by the natural conditions such as precipitation only; so all of the generation is common with or without the project. Thus we assume that they cannot change their rate of operation to compensate the CDM project. For nuclear, we assume that it is operated in full, so it has no room for variable operation.[29]

In this case, baseline emissions, CO_2 intensity, electricity generation, generation capacity of the power network, and rate of operation are all time dependent. They vary year by year through the monitoring/measurement. In other words, we should take note that the state (*e.g.*, capacity of the network) at the time of project will *not* be kept *static*, even the baseline *methodology* is invariant. Therefore, the defined methodology is not bad approximation (well describe the baseline scenario) even in the developing countries with high growth of electricity demand, if the project size is less than the reserved capacity.

5.2. Generalization

Can this methodology be applied or generalized to the 'similar' projects? Here we are going to follow the flow of way of thinking. In the case mentioned above, we set 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.

Here we simulate the generalization way of thinking to the 'similar' projects by expanding the assumptions mentioned above.

First, let us consider the generalization related to the connection to the power network. How about the construction of new but non-connected power plant case? If there exists a plan to connect to the network in the region concerned, we do not have to prepare special solution. In the case of isolated island without any plan, we can choose diesel plant as the most appropriate alternative generation method. This selection may conflict with the criterion "most likely to occur in the absence of the project" in the case that electrification will probably not take place for some time. This paper proposes to use the diesel as the baseline power plant even in this case using the benchmarking approach mentioned in the section 3. We believe that the electrification is very important element of the sustainable development—one of the main objectives of the CDM, so we can judge *politically* important to choose the alternative

[29] We can envisage the situation that these assumptions are not appropriate such as the case of variable operation of nuclear. In this case, there are two ways for generalization as "define the inappropriate case and develop new formula", and "apply existing methodology to balance the administrative costs/technical difficulties and other benefits".

power plant than insisting on the criterion.[30] On the other hand, it might be better to choose another reference alternative rather than diesel in the case of private firm electric generators not connected to the power network.

In the case of network-connected case, we have a variety of cases to expand methodology, such as (1) the connected network does not cover the whole country, (2) network is connected to other countries with large electricity trade (*mean* concept of CO_2 intensity might be better to cover connected network as well), (4) operation of the power plant of the project is very characteristic to meet the load curve (*uniform* increase of rate of operation might be reconsidered).

Secondly, we imagine the case that the capacity of the power plant is large and cannot be compensated by increasing the rate of operation of other plants in the network (*e.g.,* more than reserved capacity like 5% of whole capacity). Usually, we expect that there is a power source development plan in this case, however, we can choose the most probable reference power plant based on a rule for latest 5 years examples in the case of no plan available. In this case, we can choose CO_2 intensity of the reference alternative plant.[31]

Thirdly, let us consider the case of various outputs. In the case of combined heat and power (CHP), we can deal with the power part as the case of sole electricity generation case. The thermal part can be separately treated as selecting most common boiler (definition is needed) as the baseline reference heat source independent of the power part. In other cases, each output can be separately calculated.[32]

Finally, let us consider the case of existence of the concrete alternative power plant development plan. It may depend how concrete the plan is; however, we do not judge this item here in order to avoid complexity. If it is not connected to the network, it may appropriate to use the (mean) CO_2 intensity of alternative plant(s) (which are planned to construct in the same year). Here we set the same baseline methodology for the connected case also. As shown in the Annex, this can be proved to be adequate if the electricity generation of the alternative plant is set identical to that of CDM project. It is not necessary to have the same generating *capacity* between alternative and project plants. This method is also valid for the case of selecting the system boundary as the whole network.

We have discussed the expansion of only one or two assumptions of 1–4, we can also generalize to multiply the methodologies as well (this may needs some other methods). The results may differ among the order of the branch (*i.e*., *AB* ? *BA*).

Expanding the methodology, we should clearly define the applicable range of original

[30] In general, electrification seems to play an important role in the various kinds of development. It also has an effect to repress the population growth.

[31] We can incorporate the estimation of the indirect effects (leakage and spill-over). However, it is rather difficult technically. Standardization might be very tough job as well. It may consume time until reaching the agreement.

[32] However, the reference sources might be different dependent on the priority of the plural outputs (not only the energy outputs). For example, two separate treatments are possible for CHP whether the prioritized output is electricity or heat. This tendency might be enhanced for more outputs cases like electricity, heat, steel, and so on.

methodology, especially for the continuous parameters. This definition might be done at the time of development/definition of a methodology specific to a project; however, it might be better to do at the time of generalization.

Other points to be taken into account are, for example,

- **Leakage issue**:
  This issue is equivalent to the issue of system boundary.[33] Leakage or spill-over (negative leakage) is categorized as technical one and economical one. Technical one is easier to handle. It can be interpreted as selecting the system boundary with invariant demand (within network in the above example). The economical system boundary includes more indirect interacting sectors/regions. Economical leakage issue should be considered for large-scale project only or are dealt with some standardized correction factor.

- **Site-specific issue**:
  The specific issues like the host country policy (change) might be considered as well. In some developing countries, legal provisions do not always represent the real world situation. Cheating relate to preparing the statistical data set may be considered.

- **Mid-long term considerations**:
  For the long time frame issues, such as electricity generation mix, a country with firm power development plan tends to include long-term perspectives like energy security into the planning of new power plant development. The most likely to occur guiding principle mentioned here only includes short-term considerations. Some correction may be applied in this case.

- **Plural baseline scenarios case**:
  If it is difficult to identify one probable scenario without the project, we may set the scenario as weighted average of those scenarios.

Of course, it remains some doubt whether the standardized methodology developed through this approach well represents the most likely to occur scenario. In this case, we must seek balanced solution *politically* of low administrative costs and our level of acceptance thinking over the data availability and so on.

5.3. Flow chart

Here we try to depict above process of standardization as a flow chart or decision tree in Figure 4. This figure itself represents the standardized baseline methodology for power plant construction CDM projects.

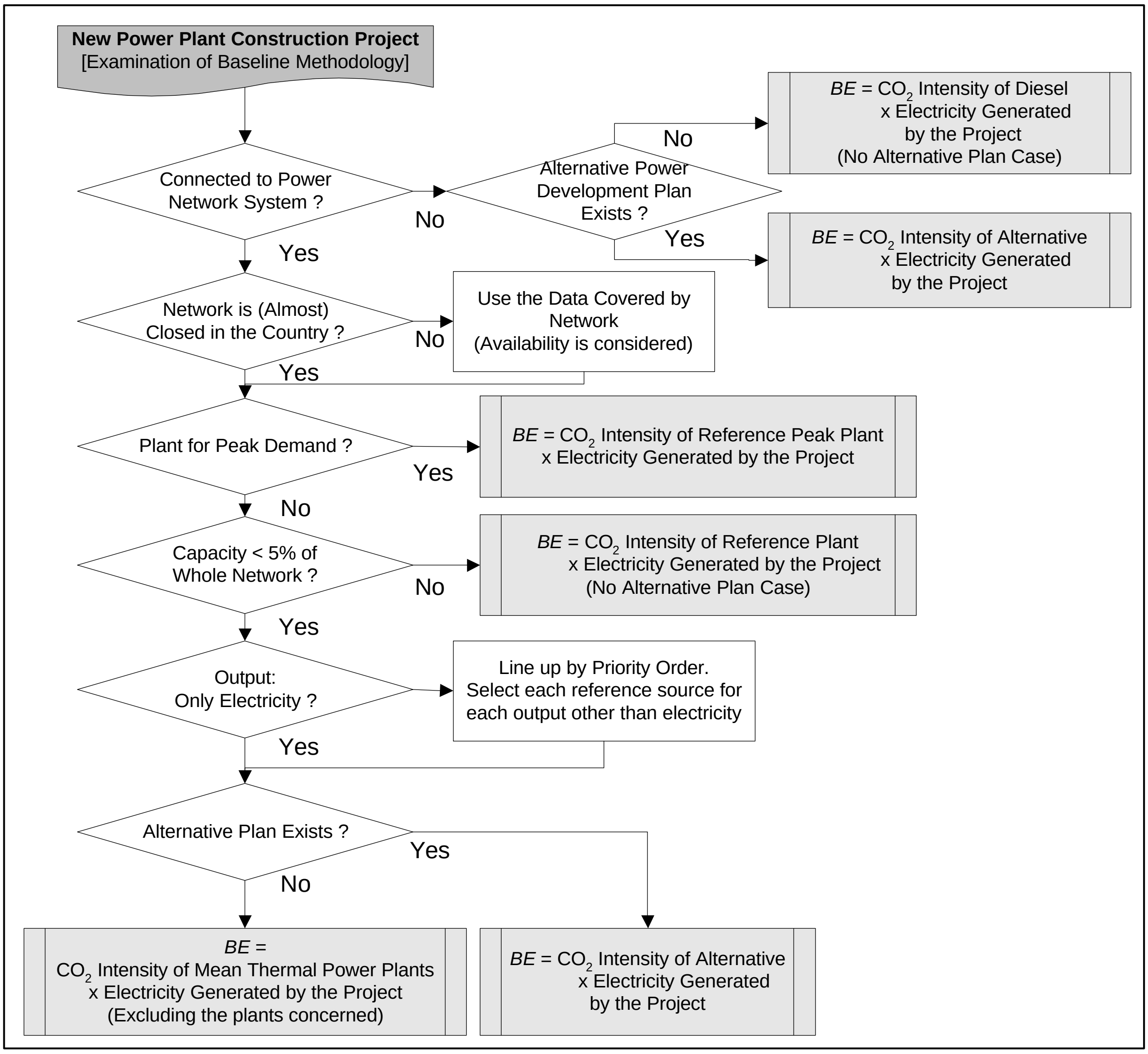
However, this flow shows only the flow of way of thinking or approach. The final output—standardized set of methodologies for new power plant construction type projects—can be a multi-dimensional matrix with dimensions of these decision junctions and applicable

[33] In theory, there are no leakages if we choose globe as the system boundary. The balanced approach is preferable considering costs and technical difficulties.

conditions.   Each formula locates at one cell of the matrix.

We have neglected some other points, so we can expect more divergent flow chart as a final standardized methodology set.   Especially, we might need some condition related to the data availability, which is not dealt with in this paper.

Figure 8: An example of simplified decision flow for step-by-step standardization



6. Future Prospects

In this report, how to deal with "standardization" issues on the baseline problems is suggested. That is, "to approach with the baseline problem by starting with an specific case and after that generalizing the methodology gradually". This kind of approach tries to deal with both considering individual projects with particular situations and standardizing the baseline methodology, which seems conflict with each other fundamentally. This approach tries to embody one of the ways to build overall CDM scheme on a step-by-step basis.

In order to develop CDM scheme, it is necessary to start projects as early as possible. However, it is difficult preparing all of the types of standardization of the CDM baseline methodologies within such a short time before COP 6 considering the limited resource of negotiations. On the other hand, the method suggested in this paper will be useful in that it can expand and develop the standardization by "Learning-by-Doing" and "Step-by-Step."

For attaining this objective, an organization, which is responsible for technical examination, should be established in an early stage as mentioned in 3.2. Probably, as regards this issue, it is expected to reach an agreement about setting up an organization like a Technical Committee at COP 6. It can be said that studies focusing on the technical aspects are needed promptly.

Acknowledgements

Discussions at the two committees for the baseline issues, which are held by MITI and EA, are helpful for writing this paper. Some other Japanese stakeholders gave me useful inputs as well. The discussions at the baseline expert workshop held in Amsterdam (January, 2000) stimulated me into revising the paper at several points including the role of benchmarking.

Annex: Baseline for Network-Connected Case

In the Annex, we explain how to calculate CO_2 emissions from electricity generation project when it connects with a power network system. This assumptions and logics are clarified for explanation.

In the first place, we set the system boundary as the whole power network system with relatively large power-transmission line. In this case, we do not include the substitute power plant of the CDM projects and baseline cases (so-called additional power supply in general term). Moreover, we exclude nuclear and renewable energies from the network, as they may not be affected by additional power supply.

Here we set the parameters as follows:

	Power Supply Network			Additional Power Supply			Electricity Generation (kWh)	CO_2 Emissions (t-C)
	Capacity (kW)	Operation rate	CO_2 Intensity (t-C/kWh)	Capacity (kW)	Operation rate	CO_2 Intensity (t-C/kWh)		
CDM Project Case	C_0	R_P	I_0	c_P	r_P	i_P	$G_P = C_0R_P + c_Pr_P$	$E_P = C_0R_PI_0+c_Pr_Pi_P$
Baseline Case	C_0	R_B	I_0	c_B	r_B	i_B	$G_B = C_0R_B + c_Br_B$	$E_B = C_0R_BI_0+c_Br_Bi_B$

Power generation and CO_2 emissions are those of hourly number for convenience. The parameters R_B and r_B are not measurable. All parameters except for those with suffix P are recognized as mean values.[34] All except c_P and c_B are time dependent as well as total capacity of the whole system.

For a conditional equation, the electricity generations are common in these two cases:

$$C_0R_P + c_Pr_P = C_0R_B + c_Br_B \quad (G_P = G_B).$$

The reductions of CO_2 emissions by the CDM project can be found as:

$$\boldsymbol{R}^* = E_B - E_P = I_0 (c_P\, r_P - c_B\, r_B) + (c_B\, r_B\, i_B - c_P\, r_P\, i_P).$$

The equality next to $\boldsymbol{R}^*$ is a definition of $\boldsymbol{R}^*$. The first term on the right side of the equation represents a part comes from the system boundary's effect on whole network system. In general, it is not zero. The second term represents the effect of additional power supply.

[34] Plural power plants in the power development plan may be regarded as the substitute in many cases.

The reductions $\boldsymbol{R}^*$ is not ready to be determined because of the unknown variable r_B exists. Consequently, another condition is necessary as well. What kind of condition (assumption) can be considered in this case?

(1) Without substitute power supply case ($c_B = 0$)

In this case, the reductions $\boldsymbol{R}^*$ is derived as follows:

$$\boldsymbol{R}^* = (I_0 - i_P)\, c_P\, r_P.$$

This equation shows that the additional demand is met by increasing the rate of operation of other plants for baseline case (the first term is the effect of increasing rate of operation and the second term shows CO_2 emissions in the case of the CDM project).

(2) Common generation for additional power supply case ($c_P r_P = c_B r_B$)

In this case, the reductions $\boldsymbol{R}^*$ is derived as follows:

$$\boldsymbol{R}^* = (i_B - i_P)\, c_P\, r_P.$$

The equation shows clearly that the reductions are represented by the difference of CO_2 intensities between substitute power supplies of two cases. It is noted that capacities of additional plants of each case does not necessary to be identical.

Moreover, we have to notice that system boundary in this case is also the whole electric network system. That is, if the assumption (2) is recognized as reasonable, calculation can focus only on additional power projects even if whole electric network system is considered (no leakage).

This is not applicable for every other assumption cases. One exemption is the first case (1). Another example is the case to set the assumption

$$\boldsymbol{c_P = c_B}.$$

This common capacity assumption seems to be reasonable instead of assumption (2). This does not include r_B, so unique solution cannot be found. The reduction $\boldsymbol{R}^*$ in this case is

$$\boldsymbol{R}^* = c_P\, [\, I_0\, (r_P - r_B) + (i_B\, r_B - i_P\, r_P)\,].$$

The first term of right hand side is nothing but the effects by choosing the system boundary as whole network. This term does not cancel in general unless the case of equal rate of operation.

We may conclude that the common generation assumption (2) might be the best choice to define the baseline methodology (at least in the case of existence of planned alternatives); because the baseline emissions and reductions are independent of the alternative capacity and rate of operation.[35]

[35] For example, we expect a project to substitute the planned coal fired power plant by many mini-hydro power plants. In this case, there remains a problem how much of the generation from hydro are controlled in strict sense. I think that it is appropriate to set the approximation level not to consider this generation adjustment availability in order to avoid high transaction costs and complexity.

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).