CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)
Version 02 - in effect as of: 15 July 2005

CONTENTS
PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)

SECTION A. Methodology title and summary description

Methodology title:

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Title: Introduction of integrated demand-side energy saving system for existing beer brewing system

Version: 7.1

Date: 06/02/2006

Summary description:

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The key elements of the baseline methodology are: (0) applicability conditions, (1) how to demonstrate additionality and identify the baseline scenario, and (2) representation of the baseline emissions (and project emissions/leakages) by using the mathematical formula.

(0) Applicability conditions

The methodology is applied to the installation of an integrated energy saving system to an existing beer brewery facility, while such installation does not result in a new separate beer production facility.

(1) Identification of the baseline scenario

Baseline scenario options are listed for:

(A) Level of energy saving technologies applied; and

(B) Options for other purposes.

These scenarios are screened out to select a unique baseline scenario through six steps of questions on regulatory requirements, prohibitive barriers, and economical attractiveness (optional) supported by common practice analysis. For applicable technologies, the methodology applies the energy audit model.

For additionality, the Additionality Tool is applied.

(2) Representation of the baseline emissions by using mathematical formula

The baseline emissions are shown as the sum of

(beer production) * (specific energy consumption rate) * (CO_2 emission factor)

for each energy source. However, it is necessary to consider the complex situation of this type of factory-level (multiple processes) energy saving system with multiple output products. The methodology defines the specific energy consumption rates by introducing the “pilsner-equivalence” concepts for multi-products.

The characteristic of this methodology is to calculate the counterfactual value of the baseline specific energy consumption rate (SEC^{BL}_{y}) *ex post* by using the project specific energy consumption rate (SEC^{PJ}_{y}), which is measurable.

An energy intensity (specific energy consumption rate) improvement by implementation of the project is to be calculated through the following process:

- First, separate the *fixed portion* of energy intensity improvement—not dependent on time and an operating rate (only hardware-dependent)—which can be theoretically calculated from the energy audit model. This will be the main part of the reduction effect of the project.
- Then, consider the remaining portion of improvement, —the effects of an improved operating rate and *Kaizen*—which cannot be theoretically calculated by the model. Based on the theoretical consideration, an intensity improvement is to be expressed by an actual measurement for $SEC^{PJ}{}_{y}$, and the effect of *Kaizen* is to be counted by a reduction in energy intensity from the second year of the project implementation.

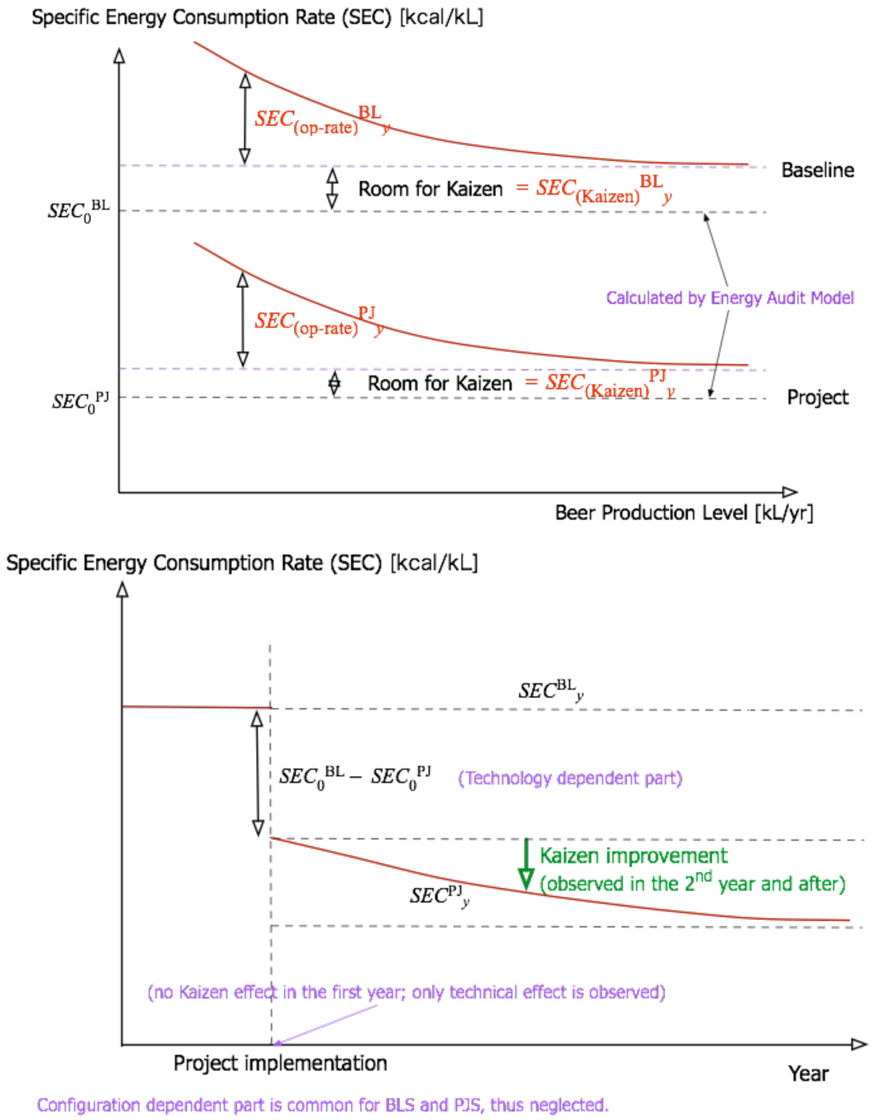

Figure NMB-1: Energy Intensity (as a Function of Beer Production) Is to Be Improved as Kaizen Practices are Introduced

[**Caption**] In general, specific energy consumption rate (*SEC* = energy intensity) is decomposed into (1) hardware (technology) dependent fixed part, (2) beer-production or process-configuration dependent

part, and (3) room for Kaizen (experience-dependent). (1) is calculated by the energy-audit model and jumps after implementation of the project. (2) is common for the baseline and project scenarios, thus neglected in the calculation. (3) is calculated *ex post* from annual improvement of the intensity. The upper figure shows the beer-production dependence of the SECs in the baseline scenario and the project scenario. The lower figure shows that the SEC develops (decreases) as time goes by (discretely at the project implementation and continuously at later stage).

If this methodology is a based on a previous submission, please state the previous reference number (NMXXXX/AMXXXX) here:

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This is the revised version of NMB for NM0118 in response to the Recommendation by the Methodology Panel.

[Note] The key differences from previous version are stressed in red.

SECTION B. Applicability/ project activity

Methodology procedure:

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Project Category

Energy efficiency improvement project:
[Demand-side energy efficiency improvements for specific industrial production]

Applicability Conditions

The methodology is applied to a CDM project activity, which installs an integrated high energy efficient utility system in the beer brewery production process in an existing factory.

The applicability conditions of this methodology are as follows:

Condition 1:

The project activity shall not result in the construction of new/additional beer production facilities with separate/new energy utility systems. Modification of the existing utility system is eligible even if new beer production facilities are added simultaneously.

Condition 2:

The project activity does not set its crediting period beyond the physical lifetime of the whole existing utility system.

The project participants shall demonstrate the lifetime by determination of the technical lifetime on a case-by-case basis, for each equipment or equipment type that is being replaced. The transparent and suitable evidences may include quantitative and/or documented information when relevant, such as catalogue spec, renovation plan, the real situation of the beer factories in the host country, *etc.* and provide conservative interpretations. The DOE assesses the validity of the evidences.

Condition 3:

The project activity does not export electricity or heat to the outside of the beer factory.

Condition 4:

The project activity does not emit effluent water under an anaerobic condition in the open air, *i.e.*, no methane is generated in the project scenario.

Condition 5:

The project participants shall use a theoretical model to have an energy audit for the beer brewery factory energy utility system. The model calculates the theoretical consumption of the utilities from the material balance and the energy balance.

Definition and explanation of the "Theoretical Energy Audit Model"

"Theoretical energy audit model" is the theoretical model to calculate the energy and

utility consumption in the beer production process from the material balance and the energy balance by using the theory of thermodynamics.

In reality, a specific model must be developed to accurately simulate a target beer factory because different factories have different facilities and equipments. Facilities and equipment expressed in the model are beer production facilities, production processes, as well as facilities for utilities (boilers, water treatment, waste water treatment, cooling systems, compressed-air generation systems, carbon dioxide recovery systems, co-generation system, *etc*.).

This model allows the theoretical calculation of energy consumption. This theoretical energy consumption is the energy consumption in a so-called theoretically optimized operation condition, which is not dependent on the operating rate and manner of the relevant facilities (see Figure NMB-1). Therefore, the output is unique and highly reliable.

It is noted that the reduction by using the energy audit model (*i.e.*, by introducing a new technology/hardware) is the principal part of the reductions.

Outputs of the model include the calculated values of necessary heat and electricity demand by product type. These are used for calculation of conversion factor of "pilsner-equivalence" for each type of products.

If the relevant utilities or the beer production facilities undergo modification, replacement or addition some point in time these effects can be theoretically calculated by energy audit model accordingly. For example, if such modification, replacement or addition would be expected in the baseline scenario (taking account of conservativeness) sometime in the future after the continuation of the current practice, new baseline parameters (especially, energy intensities) accordingly adjusted by the theoretical model must be used thereafter for the calculation of the baseline emissions in this methodology.

In addition to this adjustment for the optimized operation condition, the methodology also provides an adjustment for an actual (non-optimized) operation.

As for the outline of a beer production process and an example of the flow chart of the energy audit model, see Section L (Other Information).

Explanation/justification:

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<u>Explanation of the Condition 1</u>

The brewery may increase its production capacity gradually in order to meet the growing demand in the country, in general. The CDM project contributes only to a demand-side energy efficiency improvement (in a broad sense—to lessen the purchasing energy—including co-generation), even though the beer production capacity increases simultaneously. This is the fundamental difference between the energy saving projects (in the energy supply sector) which expand the amount of output *driven* by this kind of project simultaneously (*i.e.*, the energy saving system is not directly linked to the production of beer as the energy is only a *utility*).

In many cases, beer production facilities are going to increase its beer production capacity step by step. Associated with the increase of beer production capacity, three cases can be found to strengthen the energy utility system:

(1) The construction of new/additional energy utility systems which is basically independent of the existing utility system;

(2) The modification of the existing energy utility system (such as the exchange of some equipments) by the installation of additional line for the bottleneck beer production process (*e.g.*, brewing process. See the figure below); or

(3) no modification (if the existing one has enough capacity).

The case (2) is the case which this methodology is applicable. The case (1) is outside of the scope of this methodology. The case (3) can be found for the baseline scenario only.

In case (2), theoretical calculation is applied for the adjustment of the evaluation on a specific energy consumption rate to a lower value in the case of the baseline scenario as shown in the above definition/explanation of the energy audit model. See Section F for details.

The figure below shows an example that one of the processes (brewing process) is the bottleneck to increase beer production, while there is no need to construct new energy utility systems (case (2) above).

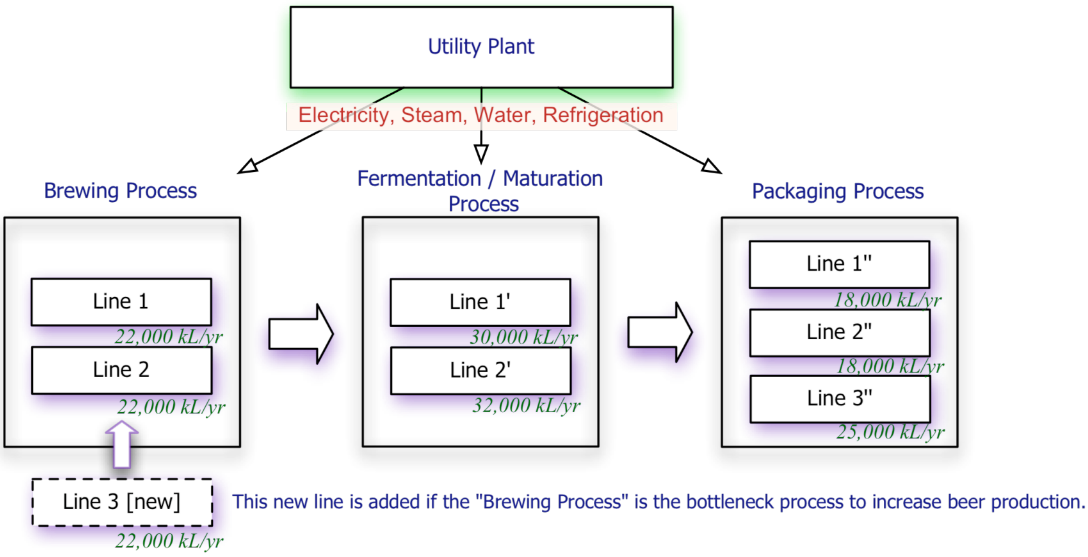

Figure NMB-2: How the "Line" Is Added in the Brewery under the Growing Demand

For the outline of the beer brewing processes, see Section L for explanation.

Explanation of the Condition 2

In reality, the utility system has been used much beyond the lifetime specified in a catalogue in many cases in developing countries. The project participants shall demonstrate why the "real" lifetime of the relevant utility system is much longer than the end of the crediting period by providing several evidences (examples specified in the methodology). It may restrain the applicable scope of the methodology too much if the evidences are limited to confirm this condition. Therefore, the methodology does not specify the concrete evidences but leaves methods for confirmation to the DOE's expert judgment for assessing the evidences provided by the project participants.

The methodology cites the approach (a) shown in paragraph 9 (In case of project activities that involve several replacements or retrofits) in the "Treatment of the lifetime of plants and equipment in proposed new baseline methodologies" in the CDM EB 22 Report Annex 2. Because the paragraph said "This approach may be appropriate if different types of existing equipment are involved".

For the modification of the utility system (*e.g.*, replacing existing equipment with new one), a theoretical adjustment is applied to calculate the baseline emissions by using the energy audit model as shown in the explanation in the Applicability Condition 1.

Explanation of the Condition 3

Although the project recycles energy in the beer brewing processes (including biogas utilization by using anaerobic wastewater treatment), the project does not generate electricity or heat to export. Such energies are utilized internally, *i.e.*, the project is for "energy-saving" only.

Explanation of the Condition 4

No methane is to be emitted in the project scenario. In many highly-energy efficient utility system in brewery, the project activity treats the wastewater aerobically and/or utilizes biogas digesters to recycle methane.

Explanation of the Condition 5

Theoretical calculation, which is used for an energy audit, is an essential requirement in the methodology to calculate emission reductions. Therefore, this condition is added. For an example of an energy audit chart for a beer brewery factory, see Section L.

All of the applicability conditions are easy to be confirmed by a validator (DOE). Therefore, no monitoring items are specified for compliance.

It is noted that there are no approved methodology with the same/equivalent applicability conditions.

SECTION C. Project Boundary

Methodology procedure:

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The project boundary is to be defined as the associated facility site and the electricity supply system (power grid or privately-owned generator) connected to it (see Figure NMB-3).

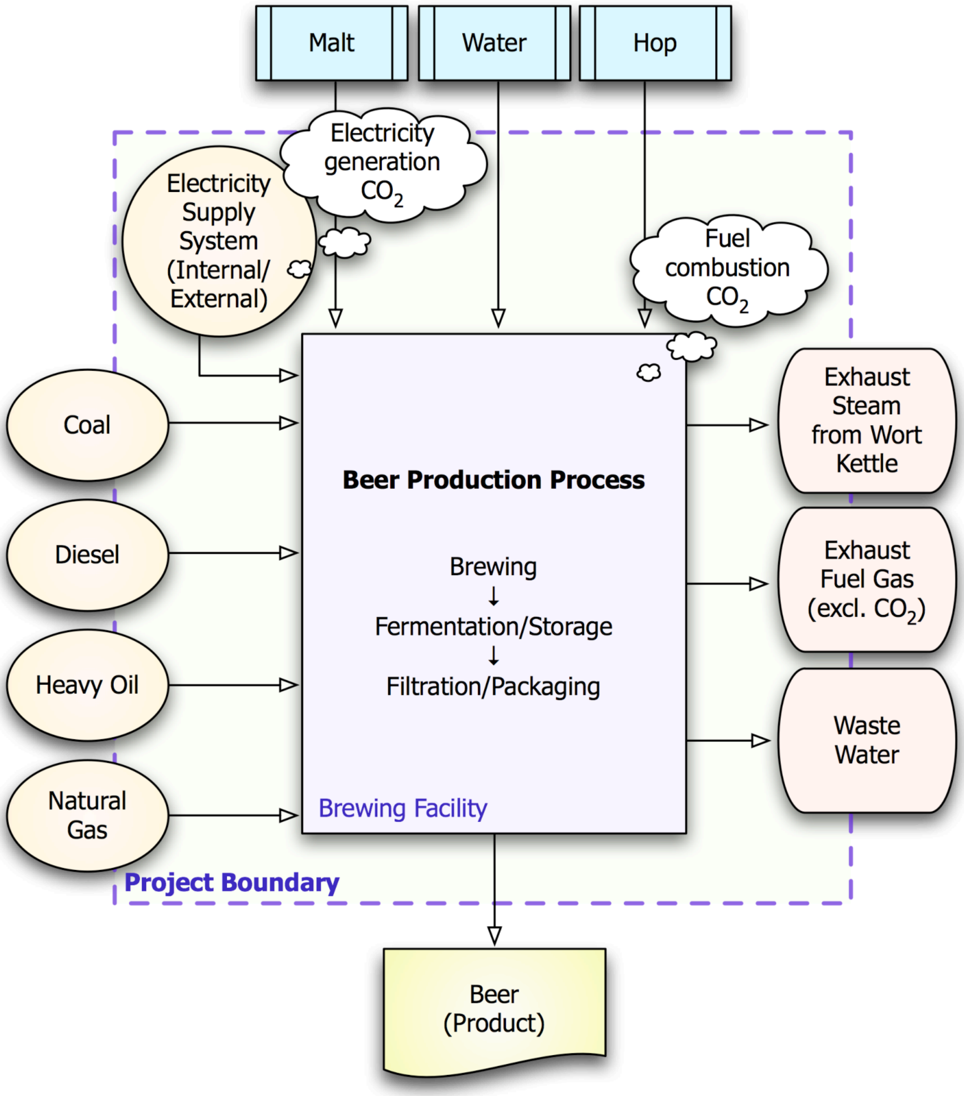

Figure NMB-3: Project Boundary for Brewery Plant Energy Saving Project

In the above figure (NMB-3), the vertical flow shows the production process for beer from raw materials to final products, and the necessary energy and emissions are shown by horizontal lines.

The associated GHG emissions (sources) are specified in the Table NMB-1 below.

Table NMB-1: Emissions Sources Included in or Excluded from the Project Boundary

	Source	Gas	Project Boundary?	Monitored?	Justification / Explanation
Baseline	Fossil fuel combustion for heat/steam supply	CO_2	Inside	Yes	CO_2 emissions from in-house fuel use as the main source of GHG emissions in the baseline scenario.
		CH_4		No	Negligible.
		N_2O		No	
	Fossil fuel combustion for internal power generation	CO_2	Inside	Yes	If any internal power generation is used to supply electricity at the beer factory, these CO_2 emissions shall be counted.
		CH_4		No	Negligible.
		N_2O		No	
	Fossil fuel combustion at the external power grid	CO_2	Inside	Yes	Indirect CO_2 emissions from the use of grid-electricity.
		CH_4		No	Negligible.
		N_2O		No	
	Transportation of fuel	CO_2	Outside	No	Negligible.
		CH_4		No	
		N_2O		No	
	Wastewater in the external pond/lagoon	CO_2	Outside	No	Neglected because it is biomass-based.
		CH_4		No	Diluted wastewater may emit CH_4 if it stays in a pond/lagoon with anaerobic condition. These emissions can be neglected, justified by conservativeness.
		N_2O		No	Negligible.
Project Activity	Fossil fuel combustion for heat/steam supply	CO_2	Inside	Yes	CO_2 emissions from in-house fuel use as the main source of GHG emissions in the project scenario.
		CH_4		No	Negligible.
		N_2O		No	
	Fossil fuel combustion for internal power generation	CO_2	Inside	Yes	If any internal power generation is used to supply electricity at the beer factory, these CO_2 emissions shall be counted.
		CH_4		No	Negligible.
		N_2O		No	
	Fossil fuel combustion at the external power grid	CO_2	Inside	Yes	Indirect CO_2 emissions from the use of grid-electricity.
		CH_4		No	Negligible.
		N_2O		No	
	Transportation of fuel	CO_2	Outside	No	Negligible.
		CH_4		No	
		N_2O		No	

Explanation/justification:

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CH_4 and N_2O emissions associated with fuel combustion are considered as "negligible".

The reasons why those can be neglected are:

- For the emissions in the project scenario, their amounts are less than those of the baseline scenario because the project consumes less energy,
- For the emissions in the baseline scenario, neglecting these *net* (positive) emissions is justified by conservativeness, and
- In addition, CH_4 and N_2O emissions are much less than the level of CO_2 emissions.

Therefore, only CO_2 emissions are to be monitored and counted for calculating the emission reductions.

GHG emissions associated with fuel transportation are neglected because:

- For the emissions in the project scenario, their amounts are less than those of the baseline scenario because the project consumes less energy,
- For the emissions in the baseline scenario, neglecting these *net* (positive) emissions is justified by conservativeness, and
- In addition, such emissions are much less than the level of CO_2 emitted from fuel combustion,

even if they are present (in the case of coal usage as the fuel).

For wastewater related GHG emissions, methane may be emitted if wastewater stays in anaerobic condition. Almost all of the mid- to large-size beer brewery factories in the world, to which small-scale CDM projects cannot be applied, have already installed aerobic wastewater treatment system in order to meet its domestic regulation for wastewater (*i.e.*, stronger anaerobic treatment system is not necessary to meet the local wastewater regulation for beer factory).

On the other hand, small to mid-size factories, which are almost on the threshold level of the small-scale CDM, may dilute the wastewater to the outside of the factory without any treatment because of the absence of the domestic regulation for such lower production level. Even for these factories, it is expected that the aerobic treatment system is needed as they expand their beer productions in the baseline scenario.

As the project scenario does not emit CH_4 because the project utilizes

- Anaerobic biogas recovery system for energy recycling, or
- Existing simple anaerobic wastewater treatment system,

it is *conservative* to neglect the CH_4 emissions in the baseline scenario, even if they are present. Therefore, the methodology does not expand its scope to claim such CH_4 reductions from wastewater in order to avoid unnecessary complexity in the methodology.

D. Baseline Scenario

Methodology procedure:

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In order to identify the baseline scenario, the project participants shall follow the Steps 1 to 6 specified below.[1]

Step 1. Identify technically feasible options for energy saving at the beer brewing factory or other purposes

Step 1a. Technical options for energy saving at the beer brewing factory

The baseline scenario alternatives should include all possible options that are technically feasible to save the energy usage at the beer brewing factory. The category of options could include:

A. Continuation of current practice;

B. Technologies for element processes for beer production; and

C. Integrated technology system.

For Option Category B, the technologies include

- B.1. Steam pressure recovery [multiple processes];
- B.2. Vapor recompression system [brewing process];
- B.3. Refrigeration efficiency improvement [multiple processes];
- B.4. Energy saving by biomass CO_2 recovery [fermentation process];
- B.5. Packaging process improvements [packaging process]; and
- B.6. Biogas utilization [wastewater treatment process].

These options are those assessed/provided by the energy audit.

The option category C should include the proposed project activity not implemented as a CDM project.

Step 1b. Options for other purposes

The baseline scenario alternatives should include other possible alternative options to the project activity for other purposes. These options may include

a. Expansion of the beer production system (rather than improving energy utility system);

b. Shut-down of the facility; or

c. Others.

If the options emit more GHGs than the most probable technical option for energy saving or continuation of current practice (*esp*. for case a), such options do not need to be assessed for conservativeness.

[1] See Figure NMB-4 for the Outline of the whole steps to identify the baseline scenario.

Step 2. Eliminate baseline options that do not comply with legal or regulatory requirements

Any options identified in Step 1 that do not and are not expected to meet with local legal or regulatory requirements should be eliminated. The project participants shall provide evidences and supporting documents to exclude baseline options that meet the above-mentioned criteria.

The regulatory requirements include those on wastewater.

Step 3. Formulate baseline scenario alternatives

On the basis of the options that are technically feasible and comply with all legal and regulatory requirements, the project participants should construct coherent and comprehensive baseline scenario alternative(s). One of these alternative(s) shall be the proposed project activity not being registered as a CDM project.

The baseline scenario alternatives should clearly identify what amount of energy would be saved theoretically using an energy audit model.

The baseline scenario alternatives should also identify how and what kind of fuel(s) and electricity is supplied to the facility considering costs, availability and technical aspects.

Step 4. Eliminate baseline scenario alternatives that face prohibitive barriers

Sub-step 4a. Identify barriers that would prevent the implementation of type of the proposed project activity:

Establish the complete list of barriers that would prevent alternatives from occurring in the absence of the CER revenue. Such barriers may include, among others:

Investment barriers *inter alia*:

- Debt funding is not available for this type of innovative project activity;
- Neither access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented, nor sufficient ODA can be allocated to finance the considered project alternatives.

Technological barriers, *inter alia*:

- Skilled and/or properly trained labour to operate and maintain the technology is not available and no education/training institution in the host country provides the necessary skills, leading to the disrepair and/or malfunctioning of equipment;
- Lack of infrastructure for the implementation of the technology.

Barriers due to prevailing practice, *inter alia*:

- The project activity is the "first of its kind": No project activity of this type is currently operational in the host country or region.

Provide transparent and documented evidences, and offer conservative interpretations of these documented evidences, as to how it demonstrates the existence and significance of the identified barriers. Anecdotal evidences can be included, but those alone are not sufficient proofs of barriers. The type of evidences to be provided may include:

(a) Relevant legislations, regulatory information or industry norms;

(b) Relevant (sectoral) studies or surveys (*e.g.*, market surveys, technology studies, etc.) undertaken by universities, research institutions, industry associations, companies, bilateral/multilateral institutions, *etc*;

(c) Relevant statistical data from national or international statistics;

(d) Documentation of relevant market data (*e.g.*, market prices, tariffs, rules);

(e) Written documentation from the company or institution developing or implementing the CDM project activity or the CDM project developer, such as minutes from Board meetings, correspondence, feasibility studies, financial or budgetary information, *etc*;

(f) Documents prepared by the project developer, contractors or project partners in the context of the proposed project activity or similar projects previously implemented;

(g) Written documentation of independent expert judgements from industries, educational institutions (*e.g.*, universities, technical schools, training centres), industry associations and others; or

Sub-step 4 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed CDM project activity):

If any of the baseline scenario alternatives face barriers that would prohibit them from being implemented, then these should be eliminated.

If all project alternatives are prevented by at least one barrier, the proposed CDM project itself is the baseline, or the set of project alternatives has to be completed to include the potential baseline.

If there are several potential baseline scenario candidates, choose the most conservative alternative as the baseline scenario and go to Step 6, or go to Step 5.

Step 5. Identify the most economically attractive baseline scenario alternative (optional)

Determine which of the remaining project alternatives that are not prevented by any barrier is the most economically or financially attractive, and then it is a possible baseline scenario.

To conduct the investment analysis, use the following sub-steps:

Sub-step 5a. Determine an appropriate analysis method

Determine whether to apply simple cost analysis or investment comparison analysis. If the project alternatives generate no financial or economic benefits other than CDM related income, then apply the simple cost analysis (Option I). Otherwise, use the investment comparison analysis (Option II).

Sub-step 5b. – Option I. Apply simple cost analysis

Document the costs associated with alternatives to the CDM project activity and demonstrate that the corresponding activities produce no financial or economic benefits.

→ ***If there are no alternatives that generate any financial or economic benefits, then the least costly alternative among these alternative pre-selected projects is the baseline.***

→ ***If <u>one or more</u> alternatives generate financial or economic benefits, then the simple cost analysis cannot be used to select the baseline scenario.***

Sub-step 5c. – Option II. Apply investment comparison analysis

Identify the financial indicators, such as IRR, NPV, cost benefit ratio, or the unit cost of service (*e.g.*, the levelized cost of electricity production in $/kWh or levelized cost of delivered heat in $/GJ) most suitable for the project type and decision-making context.

Calculate the suitable financial indicators for each of the project alternatives that have not been eliminated in Step 4 and include all relevant costs (including, for example, investment costs, operations and maintenance costs, financial costs, *etc*.), and revenues (including subsidies/fiscal incentives, ODA, *etc*. where applicable), and, as appropriate, non-market cost and benefits in the case of public investors.

Present the investment analysis in a transparent manner and provide all the relevant assumptions in the CDM-PDD, so that a reader can reproduce the analysis and obtain the same results. Clearly present critical techno-economic parameters and assumptions (such as capital costs, fuel prices, lifetimes, and discount rate or the cost of capital). Justify and/or cite assumptions in a manner that can be validated by the DOE. In calculating the financial indicator, the project's risks can be included through the cash flow pattern, subject to project-specific expectations and assumptions (*e.g.*, insurance premiums can be used in the calculation to reflect specific risk equivalents).

Assumptions and input data for the investment analysis shall not differ across the project activity and its alternatives, unless differences can be well substantiated.

Present in the CDM-PDD submitted for validation a clear comparison of the financial indicators for the proposed project alternatives.

The alternative that has the best indicator (*e.g.*, highest IRR) can be pre-selected as a baseline candidate (Step 5.d) shall be performed for all projects alternatives that have not been eliminated in Step 2.

Sub-step 5d. Sensitivity analysis:

Include a sensitivity analysis to reasonable variations in the critical assumptions , which shows whether the conclusion regarding the financial attractiveness is robust. The investment analysis provides a valid argument in selecting the baseline only if it consistently supports (for a realistic range of assumptions) the conclusion that the pre-selected baseline is likely to remain the most financially and/or economically attractive.

In case the sensitivity analysis is not fully conclusive, select the most conservative among the project alternatives that are the most financially and/or economically attractive according to both Steps 5.c and the sensitivity analysis in this Step 5.d, for example. If the sensitivity analysis shows that one or more project alternatives compete with the one identified in Step 5.c, select the one with lower emissions.

Step 6. Common practice analysis

An analysis of the extent to which the proposed project type (*e.g.*, technology or practice) has already diffused in the relevant sector and region. This test is a credibility check to complement the above steps to determine the baseline scenario. Identify and discuss the existing common practice through the following sub-steps:

Sub-step 6a. Analyze other activities similar to the proposed CDM project activity:

Provide an analysis of any other activities implemented previously or currently underway that are similar to the proposed project activity. Projects are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and

take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, *etc*. Other CDM project activities are not to be included in this analysis. Provide quantitative information where relevant.

In case the pre-selected baseline would be with lower emissions than similar activities widely observed and commonly carried out, or would be one of them, the pre-selected baseline scenario can be adopted as the baseline scenario.

If similar activities, which are not implemented as CDM projects, are widely observed and commonly carried out and are different from the baseline scenario pre-selected and are with lower emissions, it calls into question the claim that the considered alternatives to the project activity do not face barriers or mandatory regulations or are financially the most attractive. Therefore, if similar activities are identified as above, then it is necessary to demonstrate why the existence of these activities does not contradict the claim that the pre-selected baseline scenario is economically or financially the most attractive or is not subject to barriers. This can be done by comparing the pre-selected baseline to the other similar activities, and pointing out and explaining essential distinctions between them that explain why the similar activities enjoyed certain benefits that rendered it financially more attractive (*e.g.*, subsidies or other financial flows) or why the pre-selected baseline faces barriers that have since be removed.

Essential distinctions may include a serious change in circumstances under which the pre-selected baseline would be implemented from those under which similar projects where carried out. For example, some barriers may have been removed, or promotional policies may have been implemented, leading to a situation in which the pre-selected baseline would be implemented in the absence of the CDM. The change must be fundamental and verifiable.

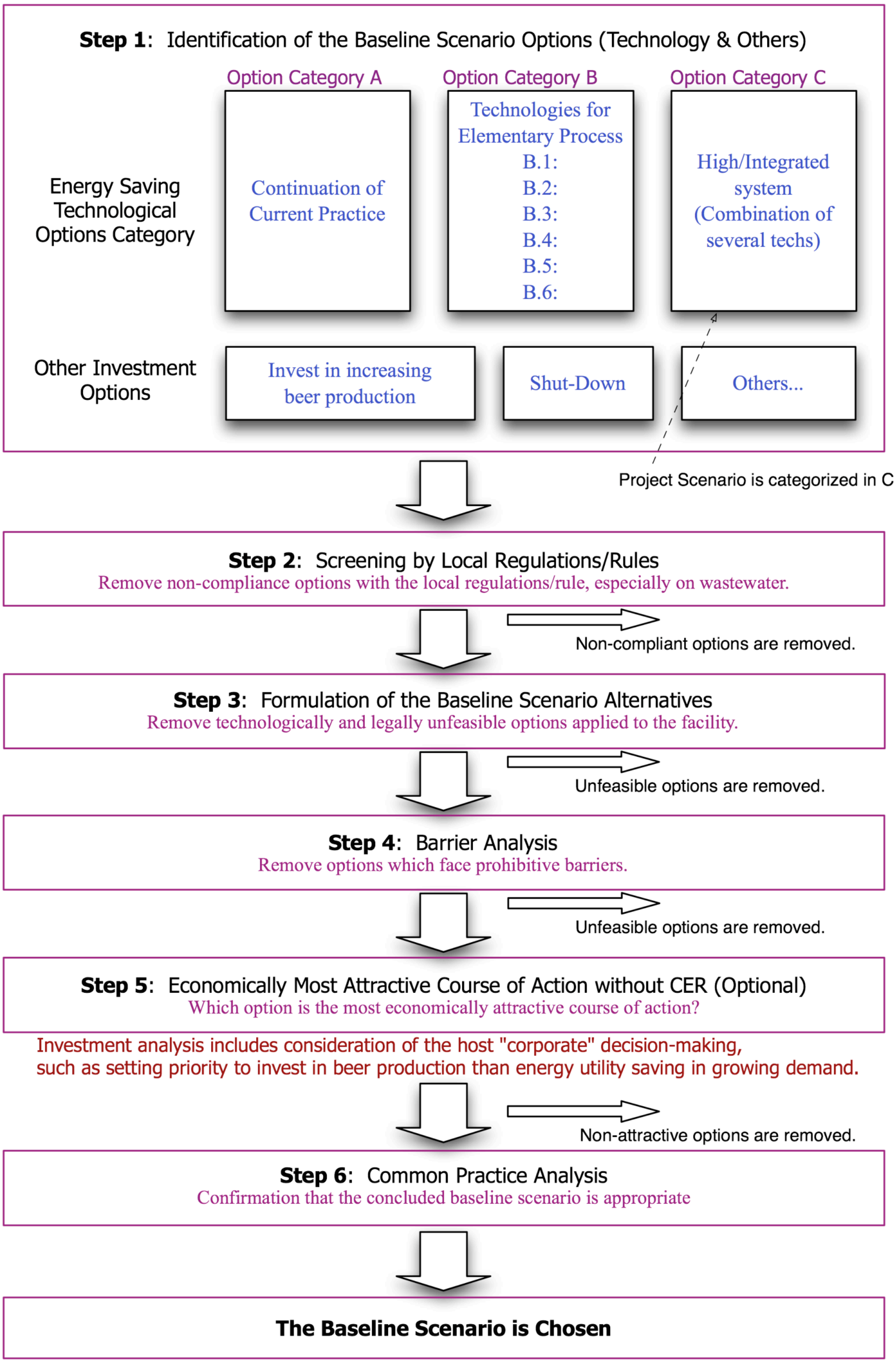

Figure NMB-4: Outline of the Steps for Baseline Scenario Identification

Explanation/justification:

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The procedures follows the steps for identification of the baseline scenario specified in the draft ACM "Consolidated baseline methodology for coal bed methane and coal mine methane capture and use for power (electrical or motive) and heat and/or destruction by flaring".

The steps identified in the draft ACM for CBM/CMM (colored black) are very comprehensive and suitable for other types of projects if relevant items are modified as appropriate (colored in blue). (Minor editorial changes are added).

For the type of energy saving project for existing beer brewery, modification specific to this type is mostly applied in Step 1 for specifying the alternative baseline options.

It is impractical to list up every technically feasible option because there are plenty of combinations of technologies. Therefore, the methodology *categorizes* the technological options into three (A: Current practice, B: Element process technologies, C: Integrated system) and specifies the qualitative explanation. For this type of project, an energy audit would be undertaken by specifying the possible realistic options and proposing the best solution. The PDD summarizes such an assessment undertaken as an energy audit. The DOE assesses details of such an audit for its appropriateness.

In the country with the rapid growing demand of beer, the decision-maker of the host company may prefer expanding its beer production capacity to renovate the energy utility system, even if such renovation itself seems economically attractive within the limited budgetary constraint. The methodology assesses such a possibility as the "most economically attractive course of action". (However, even if such scenario were chosen as the baseline, the associated baseline emissions would NOT take the expanded production level into account for conservativeness.)

SECTION E. Additionality

Methodology procedure:

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The additionality of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board.

This section elaborates on the use of the tool, and in particular how it relates to the selection of the baseline scenario. Because of the similarity of both approaches used to determine the baseline scenario and the additionality tool, step 0 and step 1 of the tool for the demonstration and assessment of additionality can be ignored.

Consistency shall be ensured between baseline scenario determination and additionality demonstration.

The baseline scenario alternative selected in the previous section shall be used when applying steps 2 to 5 of the tool for the demonstration and assessment of additionality.

The investment analysis approach, if used, should identify whether the baseline scenario selected above is more or less economically and/or financially attractive than the proposed project activity if not registered as a CDM project.

Explanation/justification:

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This is identical to the procedures specified in the draft ACM "Consolidated baseline methodology for coal bed methane and coal mine methane capture and use for power (electrical or motive) and heat and/or destruction by flaring".

SECTION F. Baseline emissions

Methodology procedure:

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Declaration of the Baseline Scenario

Here, let us declare which scenario has been identified as the baseline scenario in Section D.

This is a sort of assumption, and if the following scenario has not been identified as the baseline scenario in Section D of the PDD, this methodology is not applicable for such cases.

First, the methodology set its scope that the utility system (as a whole) would not be replaced in the baseline scenario identified by the procedures specified in Section D.

Table NMB-2: Eligible/Non-Eligible Situations (Baseline)

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="4">Beer Production Facility</td></tr>
<tr><td colspan="2">Identical to pre-project capacity</td><td colspan="2">Change from pre-project capacity</td></tr>
<tr><td rowspan="6">Utility System</td><td rowspan="2">Identical to pre-project</td><td>Project Start</td><td>Yes (ex ante)</td><td>Project Start</td><td>Yes (ex ante)</td></tr>
<tr><td>After PJ Start</td><td>Yes (ex ante)</td><td>After PJ Start</td><td>Yes (ex post)</td></tr>
<tr><td rowspan="2">Modification</td><td>Project Start</td><td>Yes (ex ante)</td><td>Project Start</td><td>Yes (ex ante)</td></tr>
<tr><td>After PJ Start</td><td>Yes (ex ante)</td><td>After PJ Start</td><td>Yes (ex post)</td></tr>
<tr><td rowspan="2">Replacement</td><td>Project Start</td><td rowspan="2">Not applicable</td><td>Project Start</td><td rowspan="2">Not applicable</td></tr>
<tr><td>After PJ Start</td><td>After PJ Start</td></tr>
</table>

[**Note**] Possible baseline situations to be assessed are listed above.
"*Ex ante*" implies to be assessed in the PDD (before implementation of the project, while "*ex post*" implies to be identified after the implementation of the project.

Through the steps to identify the baseline scenario (Section D), the baseline scenario is assumed to be identified as one of the following cases:

[Case 1] The continuation of current practice for utilities;

[Case 2] Some modification is added to the current utility system; or

[Case 3] Expanding the beer production capacity without modification of the utility system.

If the baseline scenario is not concluded as one of the cases without replacement of the utility system (see Table NMB-2), the methodology cannot be applicable to the project activity.

In [Case 2], "adjustments" associated with the "modification of equipment in the baseline" are calculated by using the energy audit model as a form of theoretical specific energy consumption rates (SECs). Namely, using the identified system (not equivalent to pre-project state), the energy audit model calculates the energy demand for heat and electricity and calculate associated specific energy consumption rates. By using these "adjusted theoretical SECs", the same procedures for the [Case 1] is applied to calculate the baseline emissions.

For conservativeness,

- Methane emissions from anaerobic state of the wastewater, if present in the baseline, and/or
- In [Case 3], incremental CO_2 emissions by the expansion of beer production

are not counted in the baseline emissions. Therefore, [Case 1] is equivalent to [Case 3] for GHG emissions in this methodology. For minor negligible emissions, not to be counted in the formula, see Section C.

Definition of the "pilsner-equivalence" concept

In general, beer factories produce multiple products (with different unit energy consumption). Separating out each of them to calculate their respective energy efficiency improvement is a highly complicated process, which is not realistic. In many cases, such measurements are impossible. Therefore, this methodology introduces the concept of "pilsner-equivalence", which enables to convert energy intensities for various kinds of beer into that for the typical beer type "pilsner". In other words, it is to calculate how many liters of pilsner can be produced from the same amount of energy that can produce 1 liter of a certain product. (This does not always have to be pilsner, and users may choose any typical kind of their products as their standard.)

Since the concept of "pilsner-equivalence" is different for electricity and heat, it should be calculated for each different product type. Pilsner-equivalent factors $EQ^{[electricity]}_i$ and $EQ^{[heat]}_i$ are calculated prior to the implementation of the project as constants by using a theoretical energy audit model for electricity consumption and heat consumption for each beer/beverage type i.

In case a product i requires α_i times of electricity and β_i times of heat in comparison to pilsner per unit volume production—driven by the theoretical energy audit model, $EQ^{[electricity]}_i = \alpha_i$ and $EQ^{[heat]}_i = \beta_i$.

Concept of "theoretical" SECs

This methodology, based on the theoretical calculation of the energy audit model[2], estimates "specific energy consumption rates (SECs) = energy intensity" in the actual factory (in a non-optimized condition) for the baseline scenario[3]. Below, if not specified, SECs means the specific energy consumption rates for the actual target factory, but its theoretical value in the optimized operation condition can always be calculated as well.

As indicated in [Case 2] above, if a "difference from the continuation of the current practice" is found in the process of identification of the baseline scenario, that "difference" is to be incorporated into the theoretical calculation by the model as an adjustment term.

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[2] As different beer factories have different facilities, a specific model that can accurately simulate the target beer factory must be developed. Calculated energy consumption is that of so-called theoretically optimized operation condition which is not dependent on the operation rate and manner of the relevant facilities. (See Section B for more details.)

[3] As for SECs for the project scenario, both theoretical calculation and actual measurement at the site are available.

Theoretical outline of the "factorization" of the SEC

The specific energy consumption rate (SEC) in the real world is dependent on many factors. The methodology decomposes it into three parts ($SEC = SEC_0 + SEC_{(\text{op-rate})} + SEC_{(\text{Kaizen})}$):

0. Technology dependent part (SEC_0):

   This part is theoretical and minimum value of SEC with ideal operation and depends only on the applied technologies (independent of time or beer-production). It can be calculated by the theoretical energy audit model. The reduction of SEC_0 is the main part of the project activity.

1. Operation rate (or beer production) dependent part ($SEC_{(\text{op-rate})}$):

   This part is dependent on the operation rate (or approximately beer production) and decreases as the operation rate (or beer production) tends to 100% (or grows). For beer factory, this part is dependent on the cleansing process of the devices between each production and each transportation of crude-beer *via* pipe, *i.e.*, dependent on the spatial configuration of the beer production processes.

2. Reducible part by "Kaizen" practices ($SEC_{(\text{Kaizen})}$):

   Kaizen is a various types of "software"-type continuous (year- by-year) incremental improvement process.

For each part of SEC, the project may contribute for reduction (improvement). For more detailed explanation, please see Figure NMB-1 and the Explanation/Justification part of this Section.

General formula for the baseline emissions

The amount of baseline emissions BE_y in a year y is given by

$$BE_y = Q_y^{[\text{Electricity-eq}]} * \textstyle\sum_k SEC^{\text{BL(el)}}_{k,y} * CEF_{k,y} / (1 - Loss_{k,y})$$
$$+ Q_y^{[\text{Heat-eq}]} * \textstyle\sum_K SEC^{\text{BL(heat)}}_{K,y} * CEF_{K,y} \quad [\text{tCO}_2/\text{yr}] \qquad (1)$$

where

$Q_{i,y}$: annual production of beer/beverage at the facility of a category i (*e.g.*, pilsner, ale, stout, juice, *etc.*) [kL-beer/yr],

$Q_y^{[\text{Electricity-eq}]}$: annual production of "beer" at the facility [kL-beer/yr] calculated by using "pilsner-eq." for electricity, defined as $\sum_i Q_{i,y} * EQ^{[\text{electricity}]}_i$,

$Q_y^{[\text{Heat-eq}]}$: annual production of "beer" at the facility [kL-beer/yr] calculated by using "pilsner-eq." for heat, defined as $\sum_i Q_{i,y} * EQ^{[\text{heat}]}_i$,

$EQ^{[\text{electricity}]}_i$: pilsner-equivalent energy consumption factor for electricity of a category i [no dimension],

$EQ^{[\text{heat}]}_i$: pilsner-equivalent energy consumption factor for heat of a category i [no dimension],

$SEC^{\text{BL(el)}}_{k,y}$: specific energy consumption rate (energy intensity) for electricity use in the baseline scenario [MWh/kL-beer or MJ/kL-beer] of the energy type k (such as external electricity, fuels for internal power generation),

$SEC^{BL(heat)}_{K,y}$: specific energy consumption rate (energy intensity) for heat use in the baseline scenario [MJ/kL-beer or MWh/kL-beer] of the energy type K (such as coal, heavy oil, diesel oil, *etc*),

$CEF_{k,y}$ ($CEF_{K,y}$): CO_2 emission factor of energy k (K) [tCO_2/MJ or tCO_2/MWh]

$Loss_{k,y}$: transmission and distribution loss of the grid for k = external electricity. Otherwise, $Loss_{k,y}$= 0 [no dimension].

$Q_y^{[\ ]} = \sum_i Q_{i,y} * EQ^{[\ ]}_i$ is the annual production of beer at the facility [kL-beer/yr] calculated by using "pilsner-eq. (for electricity)" and "pilsner-eq. (for heat)", *i.e.,* adjusted beer production.[4]

It is noted that $EQ^{[\ ]}_i$ is different for electricity use and heat use. $Q_{i,y}$ is assumed to be common for the baseline scenario and the project scenario and monitored *ex post*.

Summation is for the fuel for heat part (over K); and electricity and fuel for power generation for electricity part (over k) [tCO_2/MJ or tCO_2/t-fuel, tCO_2/l-fuel] consumed in the facility (measured annually). It is noted that $Q_{i,y}$ and $SEC^{BL(el)}_{k,y}$, $SEC^{BL(heat)}_{K,y}$ are monitored and estimated *annually* basis ($SEC^{BL(el)}_{k,y}$, $SEC^{BL(heat)}_{K,y}$ are functions of the beer production).[5]

For the notation of SECs in the project scenario (which are measured *ex post*), the superscript "PJ" is attached instead of "BL".

Estimation of $SEC^{BL(el)}_{k,y}$ and $SEC^{BL(heat)}_{K,y}$

First, the methodology tries to estimate the specific energy consumption rate for *heat* ($SEC^{BL}_{heat,y}$) and *electricity* ($SEC^{BL}_{electricity,y}$) regardless of its origin (*e.g.*, fuel type or grid/internal power generation). In case one fuel for heat and one electricity source is used, the process is simple:

$$SEC^{BL}_{heat,y} = SEC^{BL(heat)}_{K,y} \text{, and } SEC^{BL}_{electricity,y} = SEC^{BL(el)}_{k,y} . \qquad (2)$$

Specific energy consumption rate $SEC^{BL}_{heat,y}$ and $SEC^{BL}_{electricity,y}$ in the baseline scenario is approximately regarded as a declining function of the (pilsner-equivalent) beer production. For higher production period, these *SEC*s are expected to be lower even though the same production process is used.

Breakdown by the fuel types or power sources is specified at the end this Section.

[4] Electricity and heat are two major energy usage modes. Both of them are functions of beer production. However, the beer factory may produce several types of beer and beverages, in general. In this methodology, beer production is adjusted by each type of beer by using "pilsner-equivalence" concept (no need to specify "pilsner", while some typical type of beer is set for the basis). As "pilsner-equivalence" concept may be different for electricity and heat consumption, the pilsner-equivalent beer production has two different ones such as $Q_y^{[Electricity\text{-}eq]}$ and $Q_y^{[Heat\text{-}eq]}$.

[5] Here we follow the notation used in AM (*i.e.*, specifying the time-dependence by using the suffix y). However, it is better to specify the time-dependence by (t) or suffix which specifies (month and year), for more mathematically strict expression.

How to calculate the specific energy consumption rates (SECs) for the baseline

The methodology calculates the counter-factual baseline SECs by the following steps *ex post* (after implementation of the project):

(1) Calculate the theoretical improvement of the SECs ($SEC_0{}^{ER}{}_{\#\#} = SEC_0{}^{BL}{}_{\#\#} - SEC_0{}^{PJ}{}_{\#\#}$) by implementing the project by using the energy audit model in calculating the SECs for both scenarios ($SEC_0{}^{BL}{}_{\#\#}$ and $SEC_0{}^{PJ}{}_{\#\#}$).

(2) Calculate the SECs in the project scenario over time, which is measurable after implementation of the project. The improvement from the first year is recognized as "Kaizen" effect.

(3) Calculate the SECs contributing the emission reductions ($SEC^{ER}{}_{\#\#,y}$).

"##" denotes "electricity" or "heat".

Table NMB-3: Summary of the Factorization of the SECs

	Baseline Scenario	Project Scenario	Emission Reductions
Technology-dependent part (*fixed part*)	$SEC_0{}^{BL}{}_{\#\#}$	$SEC_0{}^{PJ}{}_{\#\#}$	$SEC_0{}^{ER}{}_{\#\#} = SEC_0{}^{BL}{}_{\#\#} - SEC_0{}^{PJ}{}_{\#\#}$
	Calculated by energy audit model		
Configuration-dependent part (*decreases as operation rate or beer production grows*)	$SEC_{(op\text{-}rate)}{}^{BL}{}_{\#\#,y}$	$SEC_{(op\text{-}rate)}{}^{PJ}{}_{\#\#,y}$	$SEC_{(op\text{-}rate)}{}^{ER}{}_{\#\#,y} = 0$
	Can be set as *common* for the baseline and project scenarios. Therefore, no need to be calculated		
Software-dependent part (*improves as experiences are accumulated: Room for Kaizen*)	$SEC_{(Kaizen)}{}^{BL}{}_{\#\#,y}$	$SEC_{(Kaizen)}{}^{PJ}{}_{\#\#,y}$	$SEC_{(Kaizen)}{}^{ER}{}_{\#\#,y} = SEC^{PJ}{}_{\#\#,y=1} - SEC^{PJ}{}_{\#\#,y}$ (currently no Kaizen case) or $= SEC_0{}^{ER}{}_{\#\#}$ (if currently Kaizen is detected)
	Set as a constant (no improvement: currently no Kaizen case)	Measured as the improvement from the 1st year after implementation	
Total Emission Reductions	$SEC^{ER}{}_{\#\#,y} = (SEC_0{}^{BL}{}_{\#\#} - SEC_0{}^{PJ}{}_{\#\#}) + (SEC^{PJ}{}_{\#\#,y=1} - SEC^{PJ}{}_{\#\#,y})$		

As *Kaizen* is quite a sophisticated practice, it may be assumed that it is not usually applied for the baseline scenario. That can be confirmed by the DOE through following procedures:

- Confirming that there is no place for *Kaizen* like some management plan and/or practices for improvement provided in the target beer factory, or
- Conducting interview about the actual practices of beer factories at the brewers' association, *etc.* in the target country.

However, if *Kaizen* should already be implemented in the target factory, the *Kaizen* effect in the project should be made zero (not counting its effect for either BLS or PJS). Only a difference between BLS and PJS theoretically calculated should be counted as emission reductions.

In this methodology, when *Kaizen* is not detected in the baseline scenario, the chronological intensity reduction in the project scenario is to be considered as *Kaizen*. In general, energy efficiency tends to deteriorate due to aging. Therefore, this calculation can be considered as conservative.

The resulted specific energy consumption rate in the baseline scenario is given by:

$$SEC^{BL}_{\#\#,y} = SEC^{ER}_{\#\#,y} + SEC^{PJ}_{\#\#,y}$$
$$= (SEC_0{}^{BL}{}_{\#\#} - SEC_0{}^{PJ}{}_{\#\#}) + SEC^{PJ}_{\#\#,y=1} \qquad (3)$$

if significant Kaizen is not detected as the host company's current practice. The effect of an energy intensity improvement by an improved operation rate is included in $SEC^{PJ}_{y=1}$. See the explanation/justification part below for detailed explanation.

If some significant Kaizen practices are detected,

$$SEC^{BL}_{\#\#,y} = SEC_0{}^{BL}{}_{\#\#} \qquad (3')$$

i,e, only the technological improvement (constant over time) is considered as the effect of the project.

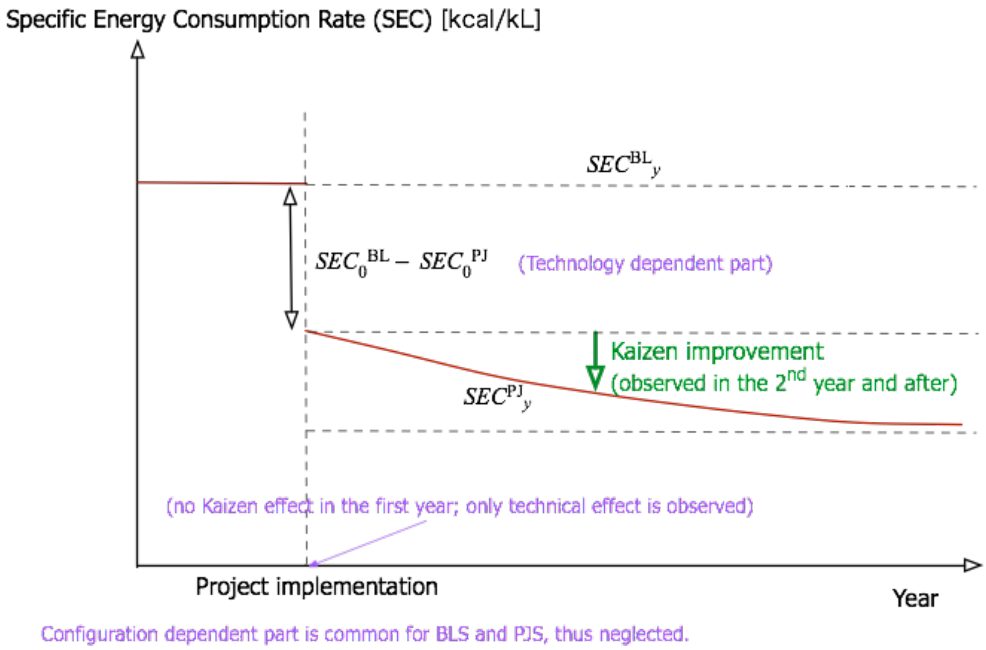

Figure NMB-5: How the Baseline Intensity is Determined

[**Caption**] This is for the case that no significant Kaizen practice is undertaken at the host company. As the configuration-dependent part is common for the BLS and PJS, technological part (SEC_0) and Kaizen

part contribute to the emission reductions. Kaizen part is considered to be the annual and continuous improvement of the SEC after implementation of the project (set as zero in the first year).

Convert $SEC^{BL}{}_{electricity,y}$ and $SEC^{BL}{}_{heat,y}$ to $SEC^{BL(el)}{}_{k,y}$ and $SEC^{BL(heat)}{}_{K,y}$ (*e.g.*, *k*: external electricity, *K*: diesel oil, heavy oil, *etc*).

Here, let us consider a case where there are multiple sources of electricity and heat.

Using the relation that electricity is supplied by the grid and internal power generation (by using some fuel):

$$Q_y^{[\text{Electricity-eq}]} * SEC^{BL}{}_{\text{electricity},y} = Q_y^{[\text{Electricity-eq}]} * SEC^{BL}{}_{\text{electricity}}{}^{\text{GRID}}{}_y + Q_y^{[\text{Electricity-eq}]} * SEC^{BL}{}_{\text{electricity}}{}^{\text{INT}}{}_y, \quad (4)$$

Therefore, counterfactual $SEC^{BL}{}_{electricity}{}^{GRID}{}_y$ (the specific energy consumption rate of external electricity) is given by

$$SEC^{BL}{}_{\text{electricity}}{}^{\text{GRID}}{}_y = SEC^{BL}{}_{\text{electricity},y} - SEC^{BL}{}_{\text{electricity}}{}^{\text{INT}}{}_y \quad (5)$$

where $SEC^{BL}{}_{electricity}{}^{INT}{}_y$ is that of internal (in-house) power. $SEC^{BL}{}_{electricity,y}$ is estimated as above (4). It is apparent if the internal power supply is absent (the second term is zero).

For $SEC^{BL}{}_{electricity}{}^{INT}{}_y$, it is reasonable to assume that $Q_y^{[Electricity\text{-}eq]} * SEC^{BL}{}_{electricity}{}^{INT}{}_y$ is common (= $Q_y^{[Electricity\text{-}eq]} * SEC^{PJ}{}_{electricity}{}^{INT}{}_y$) for the baseline and the project scenarios, therefore

$$SEC^{BL}{}_{\text{electricity}}{}^{\text{GRID}}{}_y = SEC^{BL}{}_{\text{electricity},y} - SEC^{PJ}{}_{\text{electricity}}{}^{\text{INT}}{}_y \quad (6)$$

where $SEC^{PJ}{}_{electricity}{}^{INT}{}_y$ (= $Q\_Energy_{InternalElectricity,y} / Q_y^{[Electricity\text{-}eq]}$) is that of the project scenario measured ex post.[6]

As for the heat part, $SEC^{BL}{}_{heat,y}$ is decomposed into each fuel with the same ratio of the project scenario measured *ex post*:

$$SEC^{BL}{}_{\text{heat},y} = \sum_K SEC^{BL}{}_{K,y} \quad (7)$$

with

$$SEC^{BL}{}_{K,y} / SEC^{BL}{}_{\text{heat},y} = SEC^{PJ}{}_{K,y} / SEC^{PJ}{}_{\text{heat},y} \quad (8)$$

for each fuel *K*.

Finally, calculate the annual baseline CO_2 emissions by using the beer production value *ex post*.

Estimation of $CEF_{k,y}$

For the carbon emission factor of the energy sources, internal fuel use is straightforward. Local data are to be measured or to be provided by the fuel supplier.[7] This includes fuel consumption in self-power generation.

6 It should be noted that $SEC^{PJ}{}_{electricity}{}^{INT}{}_y$ is obtained by the fuel use for in-house power generation *ex post*.

For grid electricity, the identification of *marginal* power plants is needed. In general, an abatement effect in the grid electricity is categorized as "operating margin" and "build margin" components, as in the case of renewable energy power generation connected to the grid:

$$CEF_{GridElectricity,y} = w^{OM} * CEF^{OM}_{y} + w^{BM} * CEF^{BM}_{y} \quad (w^{OM} + w^{BM} = 1) \qquad (9)$$

where CEF^{OM}_{y} and CEF^{BM}_{y} are carbon emission factors of the operating margin and build margin power plants in the grid, respectively, with associated weights w^{OM} and w^{BM}.

As for the calculation of the $CEF_{GridElectricity,y}$, the methodology includes

- the calculation methods specified in the consolidated methodology for renewable power plants connected to the grid (ACM0002), or
- the calculation methods specified in the small-scale CDM methodology for renewable power plants connected to the grid (AMS-I.D.) if the saved electricity level is less than 15 GWh_{el}/yr.

[7] The methodology aims to find out the most accurate value. Therefore, the IPCC default values should not be used in principle, instead, the local supplier's data or direct measurement by sampling should be used.

Explanation/justification:

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Overall Expression of the Baseline Emissions

The amount of baseline emissions is calculated as

(Beer Production) * (Energy Intensity) * (CO_2 Emission Factor of the Energy)

in general. However, it is necessary to consider the complex situation of this type of factory-level (multiple processes) energy saving system (see Section L for an example of the Energy Audit Chart).

The difficulties are originated from the fact that multiple inputs (electricity, heat with their sources) and multiple outputs (several types of beer) must be observed. Energy intensity (specific energy consumption rate) can be defined under the situation that the *input* and *output* is one-to-one basis.

For "inputs", taking the technological process flow of the energy use in the beer production processes at a brewery, electricity and heat do not mix each other. Therefore, the electricity usage part and the heat usage part can be divided for "inputs".

In addition, disaggregation is applied for electricity (the grid and internal power supply) and for heat (fuel types) after calculation of the specific energy consumption rates for electricity and heat.

For "outputs", pilsner-equivalence concept is incorporated to convert several kinds of beer/beverage into one using a theoretical energy audit model. A similar concept has been introduced in the UK's negotiated agreement/emissions trading scheme (Umbrella Climate Change Agreement for the Brewing Sector, 2001).

Using such techniques, the amount of the baseline emissions is given in a form of (1).

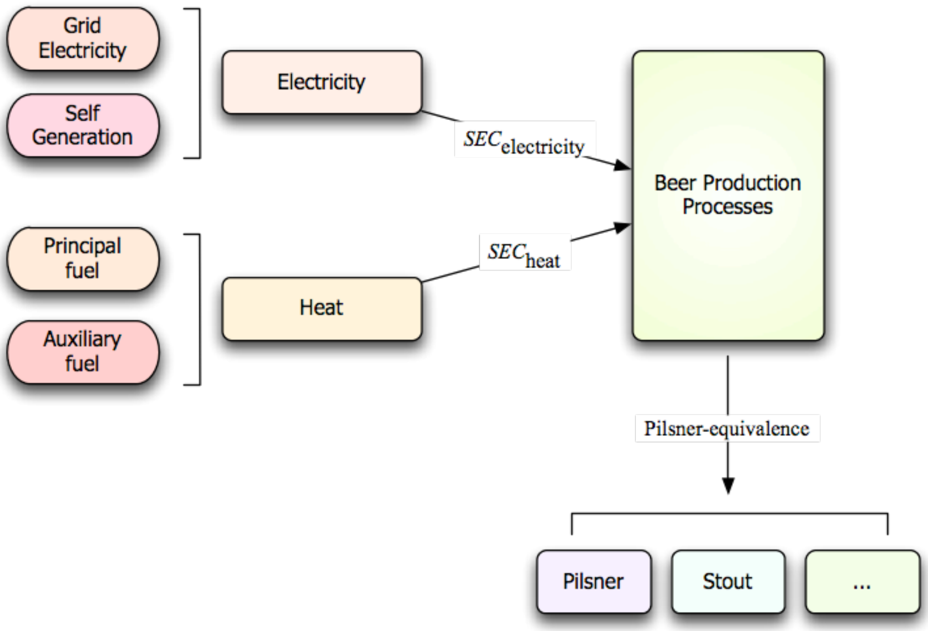

Figure NMB-6: Multiple Inputs and Multiple Outputs of the Beer Production

Breakdown of SECs

The characteristics of SECs for the baseline and project scenarios are summarized as follows:

	Values in Actual Beer Factories	Theoretical Calculation
Baseline Scenario (BLS)	Parameters cannot be measured in the real world. Formula is developed in this methodology. Variables (*ex post*).	Parameters can be calculated by the energy audit model. Fixed value (*ex ante*).
	$SEC^{BL}_{\#\#,y} = SEC_0{}^{BL}{}_{\#\#} + Gap^{BL}{}_{\#\#,y}$	
Project Scenario (PJS)	Parameters can be measured. A "difference" from the theoretically calculated value in the right hand side column shows the portion derived from non-optimization. Variables (*ex post*).	Parameters can be calculated by the energy audit model. Fixed value (*ex ante*).
	$SEC^{PJ}{}_{\#\#,y} = SEC_0{}^{PJ}{}_{\#\#} + Gap^{PJ}{}_{\#\#,y}$	

Where, suffix 0 means the theoretical value (fixed), and *Gap* means a balance between a value from the actual factory and the theoretical value (*Gap* is decomposed into two parts as shown below). In addition, if not specified, the following calculation is to be done separately for electricity consumption and heat consumption (## = heat or electricity).

Below, let us think about the theoretical calculation part (0-th order approximation) and the remaining *Gap* part (1^{st} order approximation) in the energy consumption formula for emission reductions ($SEC^{ER}{}_{\#\#,y} = SEC^{BL}{}_{\#\#,y} - SEC^{PJ}{}_{\#\#,y}$).

$$\begin{aligned} SEC^{ER}{}_{\#\#,y} &= SEC^{BL}{}_{\#\#,y} - SEC^{PJ}{}_{\#\#,y} \\ &= (\, SEC_0{}^{BL}{}_{\#\#} - SEC_0{}^{PJ}{}_{\#\#}\,) + (\, Gap^{BL}{}_{\#\#,y} - Gap^{PJ}{}_{\#\#,y}\,) \qquad (10) \end{aligned}$$

The first bracket term of the second formula is the intensity improvement derived from the theoretical calculation, which is *not* dependent on time and an operation rate or practices. When an idealistic operation is available for both of the baseline and project scenarios, this part represents the emission reductions. In an actual operation as well, it is the 0-th order (main part) of the emission reductions. This describes a "discrete" change provided by a change in hardware.

On the other hand, *Gap* in the second term means a "difference from the ideal condition" in the actual operation.

There are two other factors than the above discrete energy efficiency improvement that decrease a specific energy consumption (SEC). These are smaller 1^{st} order improvement, and a continuous change dependent on an operation rate (or production amount) or efforts (or experience and operating years):

(a) An energy efficiency improvement by an increased operating rate brought by increased beer production[8] (approximately represented as reductions in energy intensity associated with the beer production increase); and

(b) An energy efficiency improvement by *Kaizen* or efforts to improve the total quality control type operation[9] (approximately represented as reductions in energy intensity associated with years of operation and experiences).

These two factors of energy efficiency improvement are proven to be independent from each other because (a) is the function of an operation rate or a beer production amount, and (b) is the function of years of experience or efforts.

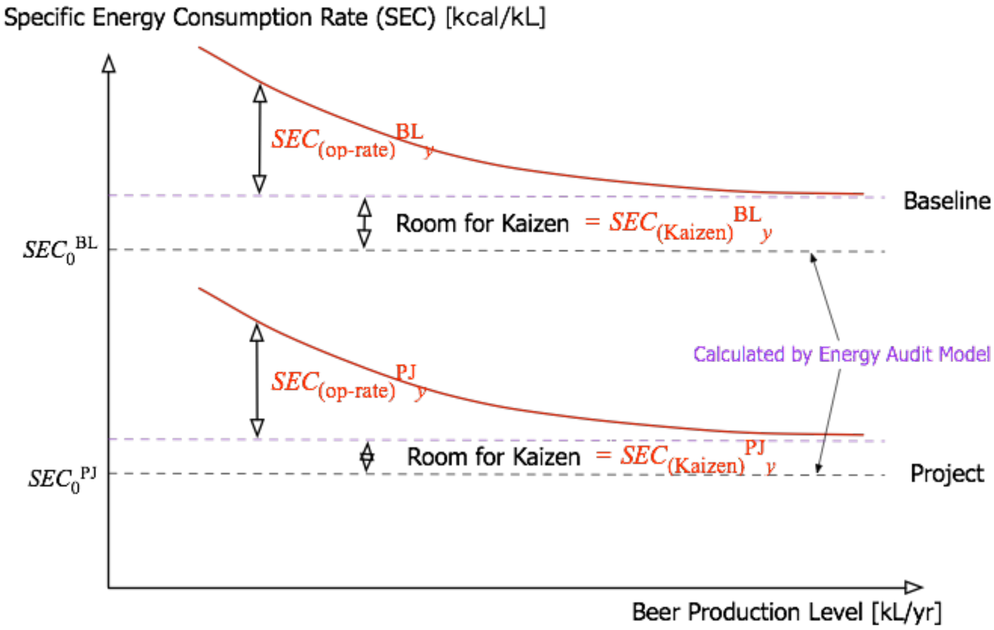

Figure NMB-7: General Concept of the Intensity-Production Relation

[**Caption**] Decomposition of the SEC for BLS and PJS. It is noted that this figure is at a certain fixed year after implementation of the project and does *not* specify the chronological development of the SECs.

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8 In the case of beer factories, energy consumption associated with cleansing (necessary for interval between production and production, or transport and transport; not included in the model) is the main part that is dependent on an operation rate.

9 *Kaizen* is a software-type continuous (year- by-year) incremental improvement process. Key elements of *Kaizen* are quality, effort, involvement of all employees, willingness to change, and communication, on the basis of the concept of “total quality control”. In other words, energy efficiency improvement consists of the “hardware” type improvement, which involves the introduction of highly efficient equipment, and the “software” type improvement, which involves an improvement in operation. The former can show its effect immediately after the introduction of the hardware, but the latter software-type shows its effect of efforts gradually year-by-year. It is well known that the potential for the latter would be substantially large especially in developing countries. A famous example of *Kaizen* is Toyota Production System. For beer production, a company in Japan has a good practice in the factories where brewers and engineers communicated each other frequently, *etc.* and have provided a successful outcome. (*Kaizen* has its origin in the management system of Japanese companies.)

The breakdown of the intensity improvement from these two factors can be expressed as follows with suffixes (op-rate) and (Kaizen):[10]

$$SEC^{BL}_{\#\#,y} = SEC_0{}^{BL}_{\#\#} + SEC_{(\text{op-rate})}{}^{BL}_{\#\#,y} + SEC_{(\text{Kaizen})}{}^{BL}_{\#\#,y} \quad (11)$$

$$SEC^{PJ}_{\#\#,y} = SEC_0{}^{PJ}_{\#\#} + SEC_{(\text{op-rate})}{}^{PJ}_{\#\#,y} + SEC_{(\text{Kaizen})}{}^{PJ}_{\#\#,y} \quad (12)$$

Where, $SEC_{(\text{op-rate})}{}^{BL}_{\#\#,y}$ and $SEC_{(\text{op-rate})}{}^{PJ}_{\#\#,y}$, which are dependent on an operating rate or beer production, is concluded as $SEC_{(\text{op-rate})}{}^{BL}_{\#\#,y} \geq SEC_{(\text{op-rate})}{}^{PJ}_{\#\#,y}$ based on the followings:

- Either an operation rate or beer production is the same for BLS and PJS,
- Its technical main source is the energy consumption related to cleansing dependent on the spatial configuration of the beer production processes, and
- $SEC^{BL} > SEC^{PJ}$.

In other words, even if a change in energy intensity dependent on an operation rate is the same for BLS and PJS (meaning that it is the same for BLS and PJS, thus not being calculated as emission reductions), it is a sufficiently conservative estimate. This means that the two curves shown in the Figure NMB-6 are in parallel. Therefore, this part can be hereinafter disregarded or set as identical for BLS and PJS, equivalently.

Namely, only the effect of *Kaizen* should be considered. A difference in SEC, that would contribute to emission reductions, can be expressed as follows:

$$SEC^{ER}_{\#\#,y} = (SEC_0{}^{BL}_{\#\#} - SEC_0{}^{PJ}_{\#\#}) + (SEC_{(\text{Kaizen})}{}^{BL}_{\#\#,y} - SEC_{(\text{Kaizen})}{}^{PJ}_{\#\#,y}) \quad (13)$$

As *Kaizen* is quite a sophisticated practice, it can be assumed that it is not usually applied for the baseline scenario in many cases.

However, in order to apply the methodology to the host company which already has undertaken some "Kaizen" practices, the methodology incorporate a checking procedures by the DOE through following procedures[11]:

- Confirming that there is no place for *Kaizen* like some management plan and/or practices for improvement provided in the target beer factory, or
- Conducting interview about the actual practices of beer factories at the brewers' association, *etc.* in the target country.

If *Kaizen* should already be implemented in the target factory, the *Kaizen* effect in the project should be made zero (not counting its effect for either BLS or PJS). Only a difference between BLS and PJS theoretically calculated should be counted as emission reductions.

In this methodology, when *Kaizen* is not detected in the baseline scenario, the chronological intensity reduction in the project scenario is to be considered as *Kaizen*. In general, energy efficiency tends to deteriorate due to aging. Therefore, this calculation can be considered as conservative.

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10 Mathematically, this means that bi-variable (production and experienced year) functions (SECs) are expanded around the point at infinity (for production and experienced year) and the terms are chosen until the first order.

11 It is almost impossible to quantify the effect of *Kaizen* by the historical energy intensity trend data, as it is *hidden* (even if it exists) in the effect due to the change of the operating rate.

Therefore, $SEC^{BL}{}_{y=1}$ in the first year of the project implementation is determined as "SEC in PJS in actual operation" + "a gap of theoretical SEC between BLS and PJS" as follows (for both heat and electricity):

$$SEC^{BL}{}_{\#\#,y=1} = SEC^{PJ}{}_{\#\#,y=1} + (\ SEC_0{}^{BL}{}_{\#\#} - SEC_0{}^{PJ}{}_{\#\#}\ ) \quad \text{for } y = 1^{st} \text{ year to implement the project} \qquad (14)$$

This means that the specific energy consumption rate for BLS is calculated from the actual measurement of SEC for PJS (*ex post*). In other words, it means that there is no *Kaizen* implemented during the first year of the project implementation (to be realized in the following years), and the room for *Kaizen* in the project is supposed to be the same as that in the baseline scenario.

As the room for *Kaizen* in the baseline scenario is larger than that in the project scenario in general, this methodology takes the conservative side in this calculation (*i.e.*, underestimating the room for *Kaizen* in BLS).

After the second year of the implementation, the *Kaizen* effect in PJS can be expected. Therefore, increments in the SEC improvement in the second year and after are to be considered as the *Kaizen* effect of the project. In this case, $SEC^{ER}{}_{y}$ that represents the emission reductions in the second year and after is to be represented as follows:

$$SEC^{ER}{}_{\#\#,y} = (\ SEC_0{}^{BL}{}_{\#\#} - SEC_0{}^{PJ}{}_{\#\#}\ ) + (\ SEC^{PJ}{}_{\#\#,y=1} - SEC^{PJ}{}_{\#\#,y}\ ) \qquad (15)$$

The second term represents the *Kaizen* effect. On the other hand, $SEC^{BL}{}_{y}$ in the baseline scenario is represented by the following formula (for electricity consumption and heat consumption separately; ## = heat or electricity):

$$\begin{aligned} SEC^{BL}{}_{\#\#,y} &= SEC^{ER}{}_{\#\#,y} + SEC^{PJ}{}_{\#\#,y} \\ &= (\ SEC_0{}^{BL}{}_{\#\#} - SEC_0{}^{PJ}{}_{\#\#}\ ) + SEC^{PJ}{}_{\#\#,y=1} \end{aligned} \qquad (16)$$

The effect of an energy intensity improvement by an improved operation rate is included in $SEC^{PJ}{}_{y=1}$.

Characteristics of the methodology compared with the previous version

The characteristic of this methodology is to express the energy intensity in the baseline scenario $SEC^{BL}{}_{y}$ using $SEC^{PJ}{}_{y}$ in the project which is measurable. Compared with the methodology using a *regression* analysis, this methodology does not require the consideration of the applicable range, and with higher accuracy. (A regression analysis can be used for *ex ante* emission reductions calculation, but this methodology describes procedures to fix the *ex post* emission reductions, and does not describe a method of *ex ante* calculation.)

This methodology calculates the energy intensity improvement by the project implementation by following procedures:

- First, separate out the fixed part of energy intensity improvement, which is theoretically calculated and not dependent on time and operation rate. This is the main part of the emission reduction effect of the project.
- Then, consider the operating rate effect and the *Kaizen* effect, which cannot be theoretically calculated by the model. Based on the theoretical consideration,

increments in the energy intensity improvement is to be represented by the actual measurement of SEC^{PJ}_{y} , and the *Kaizen* effect is to be counted by reductions in energy intensity after the second year of the project implementation.

"*Kaizen*" is an energy efficiency improvement practice which is difficult to quantify, but this methodology enables the calculation of the *Kaizen* effect by first separating out the hardware type energy efficiency effect (using the theoretical calculation by the energy audit model), and then separating out an operation rate effect by using the common factor for the baseline and project scenarios *ex post*, and finally applying several conservative assumptions for the remaining part.

As a real world practice, the example of a factory of a Beer Company, where the energy efficiency equipment of the world highest standard was introduced. It shows that *Kaizen* has been continuing to gradually develop even after 1998 when the project was implemented.

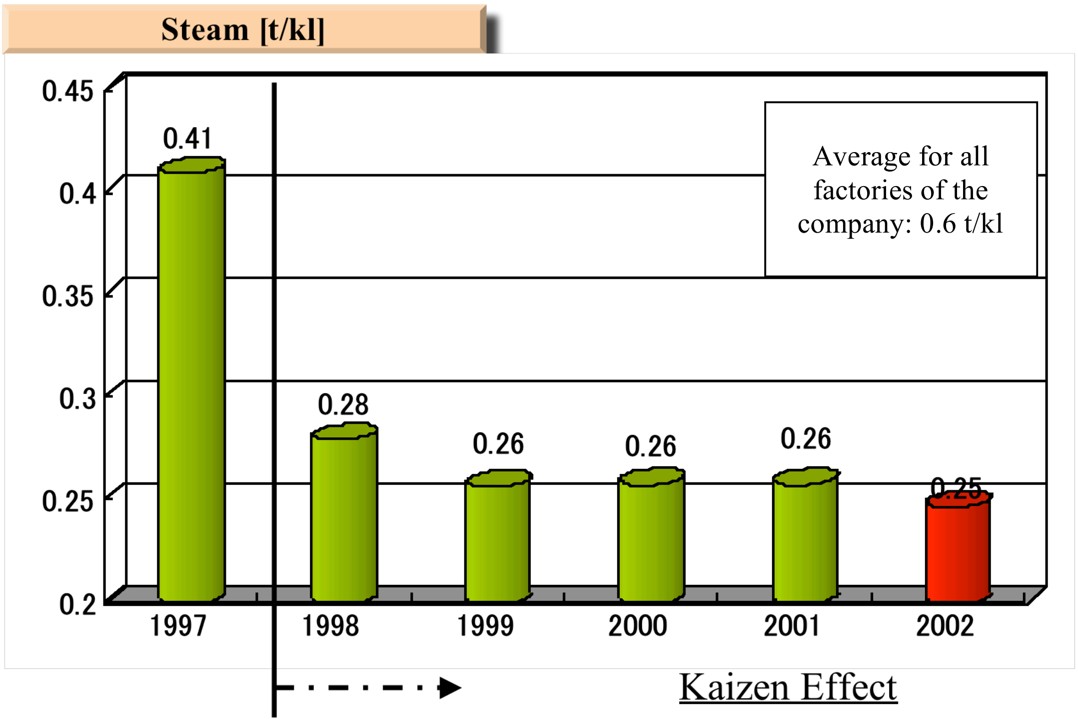


Figure NMB-8: "Kaizen" effect at a beer factory

Grid Emission Factor

For the emission factor of the grid-connected electricity, the grid electricity displacement effect is identical to those from renewable power supply to the grid. Therefore, it may be reasonable to apply the calculation method of small scale CDM if the saved electricity is less than 15 GWh/yr. If application of SSC methodology is not adequate, ACM0002 method is to be applied.

SETION G. Project activity emissions

Methodology procedure:

>>

The amount of project emissions PE_y in a year y is given by

$$PE_y = Q_y * \sum_k SEC^{PJ}_{k,y} * CEF_{k,y} / (1 - Loss_{k,y}) \quad (17)$$

where Q_y is the annual production of beer in the facility [kL-beer/yr], $SEC^{PJ}_{k,y}$ is the specific energy consumption rate (energy intensity) for energy source k of the project scenario [MJ/kL-beer], and $CEF_{k,y}$ is the CO_2 emission factor of the energy k (such as external electricity, diesel oil, heavy oil, *etc.*) [tCO_2/MJ or tCO_2/t-fuel, tCO_2/kL-fuel] consumed by the facility (measured annually).

$$Q_y * SEC^{PJ}_{k,y} = Q\_Energy_{k,y} \text{ : consumption of energy source } k. \quad (18)$$

$Loss_{k,y}$ is the transmission and distribution loss of the grid for k = external electricity. Otherwise, $Loss_{k,y}$= 0.

Explanation/justification:

>>

It is straightforward to estimate the project emissions.

SECTION H. Leakage

Methodology procedure:

>>

No significant leakage.

Explanation/justification:

>>

The possible leakages outside the project boundary are:

1. Effect of fuel transportation-related CO_2;
2. Effect of changes in the supply of raw materials such as water to the plant (due to production and transport/logistics); and
3. Macro-economic effect on beer products influenced by the project.

Here the methodology tries to assess these leakages as follows.

1. Fuel use is reduced by the project, thus disregarding such CO_2 is a conservative estimate, in addition to the fact that such amount may be minor for most cases. Strictly speaking, this is within the boundary, so it is not categorized as the leakage.
2. With regard to raw materials, it is estimated that there is no significant difference between the baseline and project scenarios because the amount of malts and hops consumed is directly related to the quality of the beer, which is identical for both scenarios.
3. By implementing this project, the macro-economic effect of an increased sales volume for the beer produced in this plant can be expected to be observed due to improved competitiveness, in theory. However, it is expected that the demand for beer in the host country is identical for both the baseline and project scenarios. This plant will only replace the sales of other brewery companies. The plant which implements this project will obtain higher energy efficiency compared to other brewery plants in the host country. Therefore, GHG emissions per unit of beer sales volume is expected to be low and the macro-economic effect is negligibly small, thus can be disregarded in a conservative manner.

Therefore, the methodology does not take such leakage effects into account as monitoring items.

SECTION I. Emission reductions

Methodology procedure:

>>

The amount of emission reductions ER_y in a given year y is

$$ER_y = BE_y - PE_y$$

$$= Q_y^{[Electricity\text{-}eq]} * \sum_k (SEC^{BL(el)}_{k,y} - SEC^{PJ(el)}_{k,y}) * CEF_{k,y} / (1 - Loss_{k,y})$$

$$+ Q_y^{[Heat\text{-}eq]} * \sum_K (SEC^{BL(heat)}_{K,y} - SEC^{PJ(heat)}_{K,y}) * CEF_{K,y} \qquad [tCO_2/yr] \qquad (19)$$

as specified in Sections F and G (as the leakage effects are negligible).

Explanation/justification:

>>

n/a.

SECTION J. Changes required for methodology implementation in 2nd and 3rd crediting periods (if relevant / optional)

Methodology procedure:

>>

The renewals of the crediting period are not allowed for the target projects of this methodology.

Explanation/justification:

>>

It may be difficult to claim for previous energy efficiency level of the baseline beyond 10 years for energy efficiency improvement type projects. Therefore, the methodology does not set its scope beyond the following crediting period.

SECTION K. Selected baseline approach from paragraph 48 of the CDM modalities and procedures

Choose One (delete others):

- ☐ Existing actual or historical emissions, as applicable;
- ☑ Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;
- ☐ The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

Explanation/justification of choice:

>>

The characteristic feature of this methodology is to choose the baseline scenario as the economically most attractive course of action. Therefore, the second approach is relevant.

SECTION L. Other Information

Explanation/justification:

>>

EXPLANATION OF BEER BREWING PROCESSES

Brewing Process

(1) Malt Milling

The malt is weighed, cleaned and crushed by a mill.

(2) Mashing

The crushed malt is mixed with hot water in a "mash tun" (tank) and allowed to stand at a temperature at 60 to 70 ^{0}C which lets the starch from the malt convert into fermentable sugars, or the crushed malt is mixed with steamed rice and hot water and heated.

(3) Mash filtering

The mash is then transferred to a "lauter tun" where the liquid is separated from the grain residue. This sweet liquid is called "wort".

(4) Wort Boiling

The filtrated wort is boiled in Wort Kettles for about 60 to 90 minutes. Hops are added into the kettle to add flavor and bitter taste. Almost 30 to 40% of steam (energy) is consumed in this process.

(5) Whirlpool

During boiling, the protein material in the wort joins together as coagulates which is removed by transferring the wort to a whirlpool to separate protein and hops that sink in the bottom.

Fermentation/Maturation Process

(6) Fermentation and Maturation

The wort from whirlpool is cooled by a heat exchanger and transferred to fermentation tanks. Yeast is then added to convert the sugars into alcohol and carbon dioxide gas at 5 to 8 ^{0}C until stopping fermentation at around 4 ^{0}C. Green beer is created after removing yeast, then matured at about 0 to –1 ^{0}C to make taste better and dissolve carbonate gas into liquid in maturation/storage tanks. "Unitank" is a combined fermentation & maturation tank. Fermentation and maturation process takes about 15 to 20 days and requires a refrigeration system which consumes 30 to 50% of electricity.

Packaging Process

(7) Beer Filtering

Surplus yeast and protein in the matured beer, which will cause degradation, is removed by filtering before bottling. The filtered beer is called "bright beer" and transferred to the bright beer tanks.

(8) Bottling and Pasteurization

The bright beer is packaged into bottles, cans and casks or kegs. Empty bottles are cleaned by hot water in the bottle washer before filling the beer by the filler. The beer is filled into bottles or cans by the filler. Pasteurization is a process of heating by hot water at 60 to 70 oC and rapid cooling by cold water which prolongs shelf-life and destroys any bacteria or other organisms in the beer. Bottling and pasteurization process also consumes 20 to 30% of steam.

Wastewater Treatment

Wastewater from brewing, fermentation and packaging processes is treated by aerobic, anaerobic or

open (dilution/lagoon) systems.

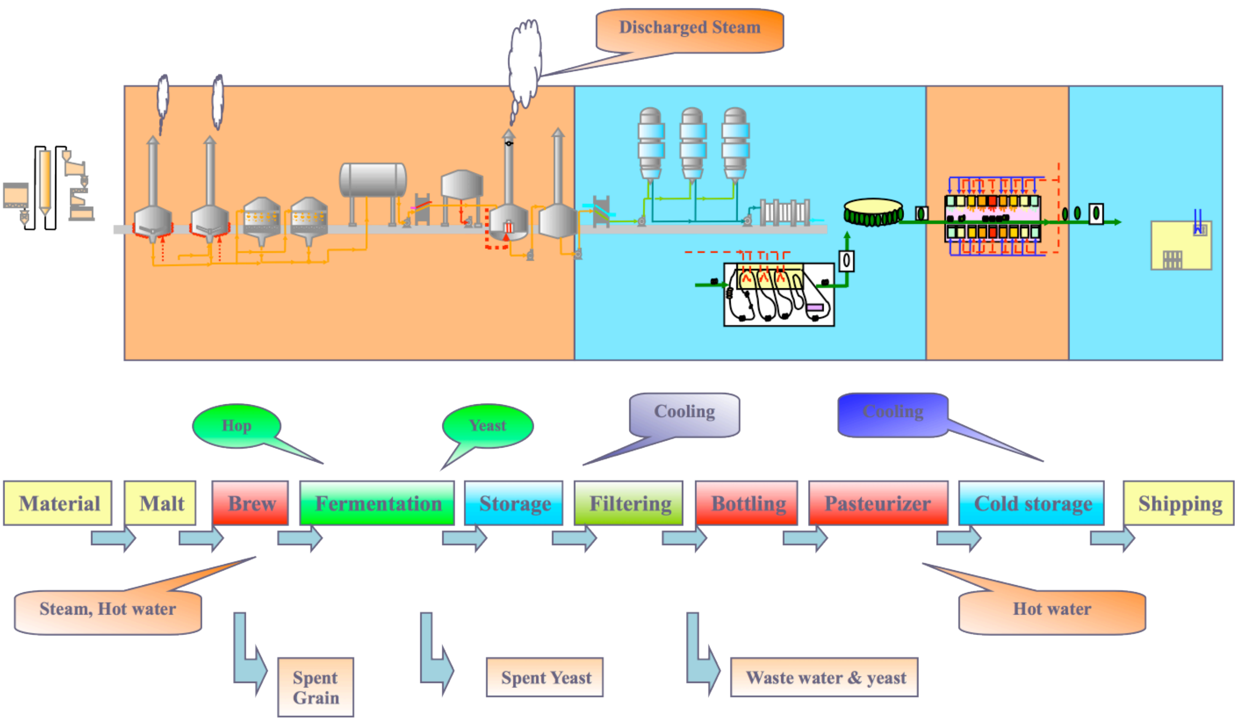


Figure NMB-5: Beer Production Process

EXPLANATION OF ENERGY SAVING TECHNOLOGIES FOR BEER BREWERY

Several energy saving technologies, which can be used at beer brewery, are outlined below as well as a typical figure for implementation of the integrated system.

(1) VRC (vapor re-compression) system

Currently, in a brewery plant, the boiling kettle in the brew-house discharges large amounts of waste steam into the atmosphere. This system recovers and compresses waste steam by a steam compressor and reutilizes recovered steam as a heat source for the Wort Kettle itself. VRC can reduce a substantial portion of steam consumption by adding only a small amount of driving power.

(2) Energy saving operation of bottle washer

This system recovers heat from warm wastewater from bottle washer for reutilization and reduces steam consumption in bottle washer.

(3) Energy saving operation of Pasteurizer

Pasteurizers in bottling and canning lines consume large quantities of steam and water because they have to be cooled down to ambient temperature after the heat sterilization process. Optimizing this process by a heat pump system will reduce steam consumption. (Reduction of steam consumption without wasting energy).

(4) Improvement of refrigeration system

4-1. Cascade cooling system

Water used in the brewing process is chilled to approximately 3 0C from ambient temperature. Because of its large temperature differential for cooling down, it is more efficient to run multiple

chiller units in series (Cascade cooling system) rather than a single chiller unit so that refrigeration COP (Co-efficient of Performance) can be improved to 8.

4-2. Dynamic ice thermal storage and transporting system

This is an ice thermal storage system for storing ice slurry (called "Dynamic Ice") made from brine freezing at –3 to –5 ^{0}C. By making ice during night at lower ambient temperature and operating the refrigeration compressors at 100% capacity, it will contribute to a reduction in power consumption rate per (cold) thermal unit produced. (Reduction of electric power by improving refrigeration efficiency).

(5) Improvement of boiler efficiency

Steam accumulator will be implemented to absorb the sharp fluctuation of steam load. The efficiency of boiler economizers which have been already installed at project site will be improved.

(6) Power recovery from high-pressure steam

A steam expander system will be implemented to recover power in depressurizing/expansion process of steam. It is aligned in-line with electric motor/generator and refrigeration compressor.

(7) Biogas co-generation with high-efficiency anaerobic wastewater treatment

Recovery of methane gas generated from wastewater treatment by anaerobic fermentation is used as fuel for cogeneration using a biogas engine. The waste heat boiler to generate steam and hot water will be used to take up large fluctuations in steam consumption in the brewing process and reduces steam and fuel consumption. It is more useful to generate electric power rather than steam generation by biogas boiler alone, because there is no use of steam during weekend when there is no brewing whilst electricity is always required to operate refrigeration plant, water treatment *etc*.

(8) Hot water recovery from air-compressors

A heat exchanger will be implemented to recover heat from the discharge line of air compressors for reutilization. It will reduce steam and fuel consumption

(9) Steam type spent grain dryer with vapor recovery system

The existing direct-fired spent grain dryers will be replaced by steam type. Waste steam will be recovered and recycled.

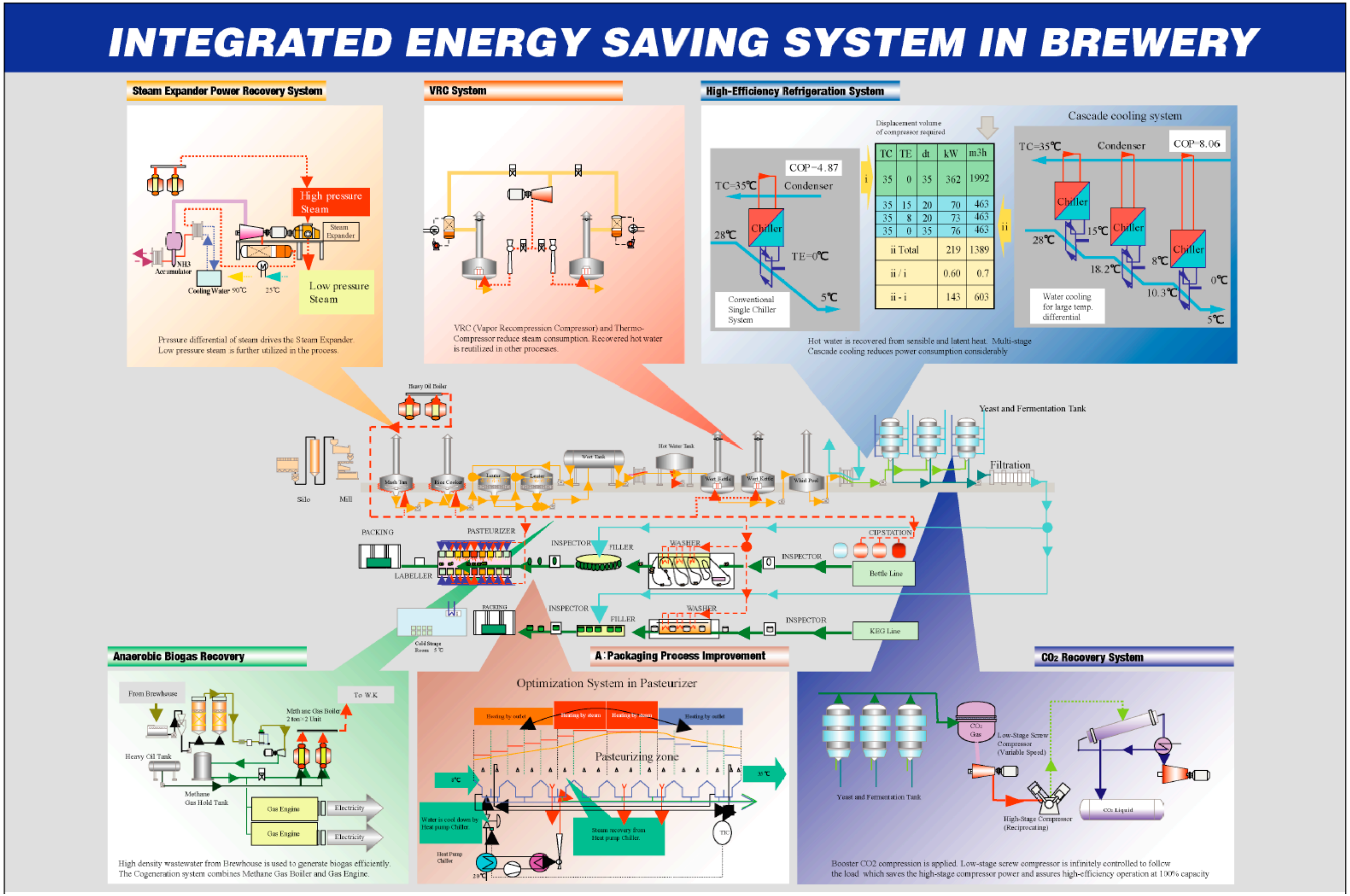
(10) Improvement of dehydration in yeast before entering yeast dryer

A dehydrator will be implemented for yeast before entering yeast dryer. It will reduce steam consumption in the yeast dryer.

(11) Improvement of CO_2 recovery rate in the fermentation process

A variable capacity compressor will be implemented as a booster in addition to existing reciprocating type compressor to improve recovery rate of CO_2.

AN EXAMPLE OF INTEGRATED ENERGY SAVING SYSTEM FOR A BREWERY



AN EXAMPLE OF ENERGY AUDIT CHART OF A BREWERY

BASIC CALCULATION SHEET & S.F BREWERY MATERIAL BALANCE (Per 1Brew 1350HL packaged Beer)