CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)
Version 01 – in effect of: 1 July 2004

CONTENTS

SECTION A. Identification of methodology

A.1. Proposed methodology title:

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Title: Specific consumption rate projection for demand-side brewery energy saving processes

Version: 5.0

Date: 30/05/2005

A.2. List of category(ies) of project activity to which the methodology may apply:

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Energy efficiency improvement project:
[Demand-side energy efficiency programs for specific technologies]

A.3. Conditions under which the methodology is applicable to CDM project activities:

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

The applicability conditions of this methodology are as follows:

[Note] Boxes are just for the explanation of the condition.

Condition 1:

The project is to install energy saving systems (*incl*. in-house heat and/or power generation) in the existing production process if it does not result in new production facility with separate/new energy utility system.

> [**Explanation**] The brewery may increase its production capacity gradually in order to meet growing demand in the country, in general. The CDM project contributes *only* to demand-side energy efficiency improvement, even though the beer production capacity increases simultaneously. This is the fundamental difference between the energy saving projects (in energy *supply* industry sector) which expand the amount of output driven by such a project simultaneously (*i.e.*, the output and the target to save are common in the energy sector, while for the beer brewery sector energy saving project, energy saving and beer production is *independent* theoretically as the energy is only a *utility*). See ANNEX for real situation of the beer factories.

Condition 2:

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

> [**Explanation**] The baseline scenario may be changed beyond the lifetime of the existing energy utility system.

Condition 3:

The project includes biogas recovery and its utilization for boiler in the system

> [**Explanation**] This condition reflects an aspect that the project installs “integrated” system to use energy efficiently. In addition, this condition ensures that no methane is

emitted from the effluent wastewater in the project scenario.

Condition 4:

Integrated up-to-date technology (*e.g.*, VRC[1] system, high refrigeration efficiency, ice thermal storage system, energy-efficient operation of pasteurizer, and biogas-boiler) for energy conservation is not installed at the factory now and not commonly installed in the host country beer brewery sector [*i.e.*, lack of experience and knowledge]. In order to assess this Condition 4, the DOE (validator) is going to assess the situations below (it is not necessary to meet all situations). The DOE may request the project participants to provide other materials to support this Condition 4.

- Lack of integrated up-to-date technology above in the host country, with a penetration rate less than 10%;
- The decision making processes of enterprises in the host country on investment places low priority on energy conservation because of little knowledge of the technical and financial aspects of energy efficiency and/or setting priority on investment for increasing beer production than for energy saving (within the limited financial resources);

Condition 5:

Reduction of energy costs by the project (through energy saving) is not the most economically attractive course of action to invest without CER revenue. The project participants shall demonstrate its rationale by providing related information to the DOE (validator). "Investment analysis" method in the "Tool for the demonstration and assessment of additionality" is applied.

Condition 6:

The grid electricity displaced effect by the project is small enough to neglect build margin component in comparison with the capacity of the grid. The project participants shall confirm this by interviewing person(s) responsible for the grid power development plan.

[1] Vapor Recovery Compressor system (a core heat pump technology). This technology is usually the core part of the integrated highly efficient energy utility system in the brewery factory.

A.4. What are the potential strengths and weaknesses of this proposed new methodology?

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This baseline methodology tries to figure out the general framework to assess demand side energy efficiency improvement type CDM projects by assessing the energy efficient levels to be considered (see conceptual figure NMB-1 in the following page).

Stage 1:

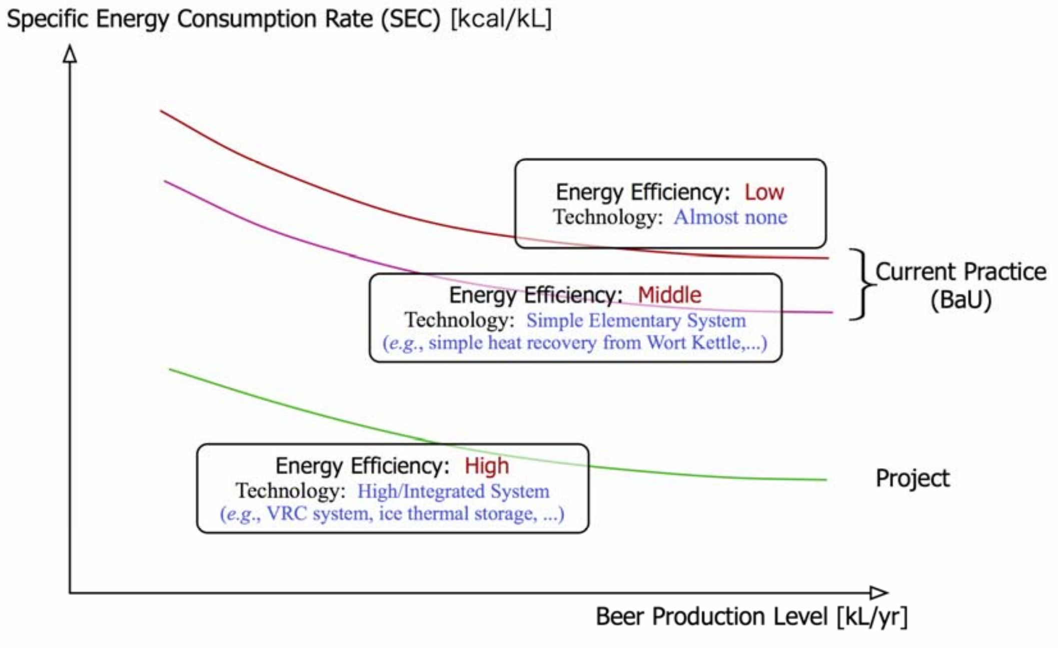
Categorization of energy saving technologies, specified by types of the technology [discrete levels of energy efficiency].

Stage 2:

For each energy saving technology, the energy efficiency may be improved as the operation rate increases [continuous energy efficiency improvement]. The methodology gives a simple and conservative method to treat this tendency.

In addition, specific energy consumption rate (energy intensity)[2] is chosen as the indicator of the energy efficiency level. This indicator is commonly used for the brewery sector. This methodology defines how the indicator works for plural outputs (several kinds of beer) and plural inputs (heat and electricity).

The methodology tries to figure out/approximate this specific energy consumption rates in the counter-factual baseline scenario by depicting the regression curve which describes future possibility to expand beer production capacity.



For each category of technologies, energy efficiency is improved as the beer production increases.

Figure NMB-1: Categorization of Energy Saving Technologies and Energy Efficiency Improvement as the Production Increases

[2] Specific energy consumption rate (SEC) is defined as "energy consumption (kL-oil, kg-coal, m^3-natural gas, kcal-heat and/or kWh-electricity) divided by unit of beer production (kL-beer)" in this methodology.

SECTION B. Overall 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) represent the baseline emissions (and project emissions) by using the mathematical formula.

(0) Applicability conditions

The methodology is applied to the installation of energy saving system in a beer brewery facility, while such installation does not increase the beer production capacity. The project implements high level of energy saving system including biogas recovery/utilization. High-energy efficient system is not installed at the facility now and not commonly installed in the host country beer brewery sector [*i.e.*, lack of experiences and knowledge]. Without CER revenue, this project is not the most economically attractive course of action.

(1) Identification of the baseline scenario

Baseline scenarios are categorized into two independent components:

(A) Level of energy saving technology used; and

(B) Type of wastewater treatment system.

These scenarios are screened out to select a unique baseline scenario by using four steps of questions on

[Step 1] compliance with the local regulation on wastewater,

[Step 2] feasibility of the energy saving technology applied to the facility, and

[Step 3] economically most attractive course of action

by using some key elements of the "additionality tool" prepared by the CDM EB. It is noted that the additionality assessment is included in this process to assess whether the project would not be implemented without CER.

Through these steps, energy efficiency level and wastewater treatment system of the baseline scenario is concluded as

- Utilizing current level of energy saving system,[3] and
- Continuation of current practice for wastewater treatment before increasing the beer production capacity. Utilizing aerobic wastewater treatment system after that.

(2) Representation 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.

In order to estimate the specific energy consumption rate as a function of the beer production level, the methodology develops regression analysis by fitting parameters of past experience.

[3] It is no use to consider the case where the government will introduce some incentive framework at a later stage, because such case is categorized as "Type E–" in the "clarification of the treatment of national and/or sectoral policies and regulations in determining a baseline scenario" at the 16th Session of the CDM EB meeting.

For the CO_2 emission factor of the external grid electricity, pure operating margin is applied (confirmation by local true-decision maker is needed). Identification of such marginal plant(s) or type(s) of plants is given based on the interviews with the local grid operator with suitable explanations or other simpler and more conservative method incorporating the operating margin elements of the consolidated methodology ACM0002 for the grid connected renewable power generation.

If an anaerobic lagoon system is used currently, methane is released until the expansion of the beer production facility. Such emissions are represented by methane emissions *ex ante* corrected by the amount of organic waste *ex post*.

SECTION C. Choice of and justification as to why one of the baseline approaches listed in paragraph 48 of CDM modalities and procedures is considered to be the most appropriate:

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C.1. General baseline approach:

☐ 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.

C.2. Justification of why the approach chosen in C.1 above is considered the most appropriate:

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This methodology demonstrates the additionality of the project, principally by assessing the economic considerations for investment decision-making. Therefore, the second approach is regarded as the most appropriate one for this methodology.

SECTION D. Explanation and justification of the proposed new baseline methodology:

D.1. Explanation of how the methodology determines the baseline scenario (that is, indicate the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity):

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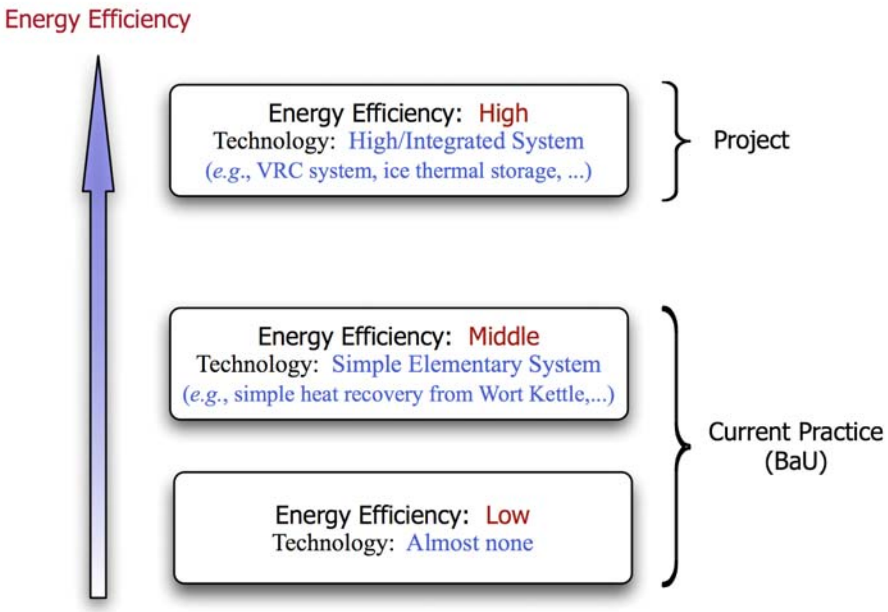
On the basis of the applicability conditions, we assess possible scenarios for the no CER revenue case, *i.e.*, baseline scenario.

The baseline scenario options are categorized into two independent components:

(A) Level of energy saving technology used; and

(B) Type of wastewater treatment system.

For **energy utility component (A)**, there are a variety of energy saving technologies. It is unrealistic to specify each technology (and their integrated structure) as the baseline scenario options. Therefore, the methodology categorizes the technologies into three.[4]



The project installs high energy efficient integrated technology such as VRC (vapour recovery compressor) system. While the facility installs almost no energy efficient technologies *or* only some simple energy saving technology now.

Figure NMB-2: Categorization of Energy Saving Technologies

Next, we set the energy efficient level of the technological baseline scenario options based on the categorization of technologies above:

- **[Option A-1] Utilizing current level of energy saving system** (if elementary technology is already installed, Option A-1 is identical to Option A-2).

[4] It is noted that the project installs high and integrated energy efficient technology set, while the facility's current situation (before implementation of the project) is to use almost no energy saving technology (Low case) or only a simple elementary technology (Middle case).

> *[**Explanation**] Beer production is to be continued and maintained with the present utility facility or by adding some line which is the bottleneck to increase beer production (see Annex for explanation of adding the line in the brewery factory). The latter case utilizes the same level of energy saving system because the system change is minor. This is the most practical case because the utility facility will be maintained as it is or with minor modification with the same technology applied.*
>
> *Maintaining status quo is to continue to use the same main fuel for boilers without implementing heat recovery from Wort Kettle if it is not implemented. The electric power consumption system will stay the same to continue to use national grid or private power generation.*

- **[Option A-2] Implementation of a simple energy saving system (elementary technology) in addition to Option A-1**.

> ***[Explanation]*** *A simple energy system is not an integrated set of technologies, but a system to install elementary technology such as condensers (pan-condenser) for the steam from the Wort Kettle and/or recovery of warm water from waste heat in the brewery plant.*
>
> *Technically, recovery of the steam from the Wort Kettle is not worth implementing for several tonnes per hour volume due to technical and economical reasons. For boilers using coal (i.e., low price fuel), economizer is not economically attractive course of action. So, this option can be possible only for heavy fuel oil boiler case in reality. This feasibility is to be checked by the validator (Operational Entity) taking the local situations into account.*
>
> *If elementary technology is already installed, Option A-2 is identical to Option A-1 (continuing current practice).*

- **[Option A-3] Implementation of an advanced energy saving system (integrated technology)**.

> *[**Explanation**] An advanced energy saving system is an integrated system such as a combination of a heat pump system to re-compress exhaust steam from Wort Kettles for re-utilization as a heat source for the Wort Kettle itself, cascade cooling using multiple refrigeration compressors in series for cooling over a wide temperature range and utilization of biogas as fuel based on anaerobic treatment of waste water. The installation cost of Option A-3 is much higher than Options A-1 and A-2.*
>
> *As specified in the applicability condition 4, this level of technology is not common in the host country brewery sector.*

The set of technologies installed in the project scenario is categorized in the Option A-3.

For **wastewater treatment component (B)**, three options can be considered:

- **[Option B-1] Simple dilution by water.**

> *[**Explanation**] The effluent is discharged after dilution by water only. In this case, biogas may be generated if discharged water is put under*

anaerobic conditions. This treatment of effluent water will not meet local environmental regulations on wastewater when beer production is increased.

- **[Option B-2] Utilizing aerobic wastewater treatment system.**

*[**Explanation**] Aerobic treatment system is a simple, low cost technology meeting environmental regulations for wastewater in most non-Annex I countries.*

- **[Option B-3] Utilizing anaerobic wastewater treatment system with biogas recovery.**

*[**Explanation**] This option is only feasible if the energy system utilizes collected biogas because it is more expensive than others.*

It is noted that the wastewater treatment system utilizes lagoon(s) and/or open natural water systems (river/rice paddy/lake, *etc*). In case of anaerobic conditions, where CH_4 is released to the atmosphere from the waste water treatment system, monitoring CH_4 emissions is possible for *a* lagoon system, while for others, it is almost impossible to estimate the methane conversion factor for COD or BOD.

In most cases, wastewater treatment technology is *common* for existing facility with or without new line(s).

In the following, the procedures how to identify the baseline scenario is provided. Figure NMB-3 depicts the outline of the steps.

[Step 0] Identification of the baseline scenario options

Based on the possible technological options shown above, technologically feasible option sets are chosen as the baseline scenario options.

In addition, investing in increasing beer production capacity (or other non-energy-saving options) can be added. For these cases, the same energy utilizing technology is used.

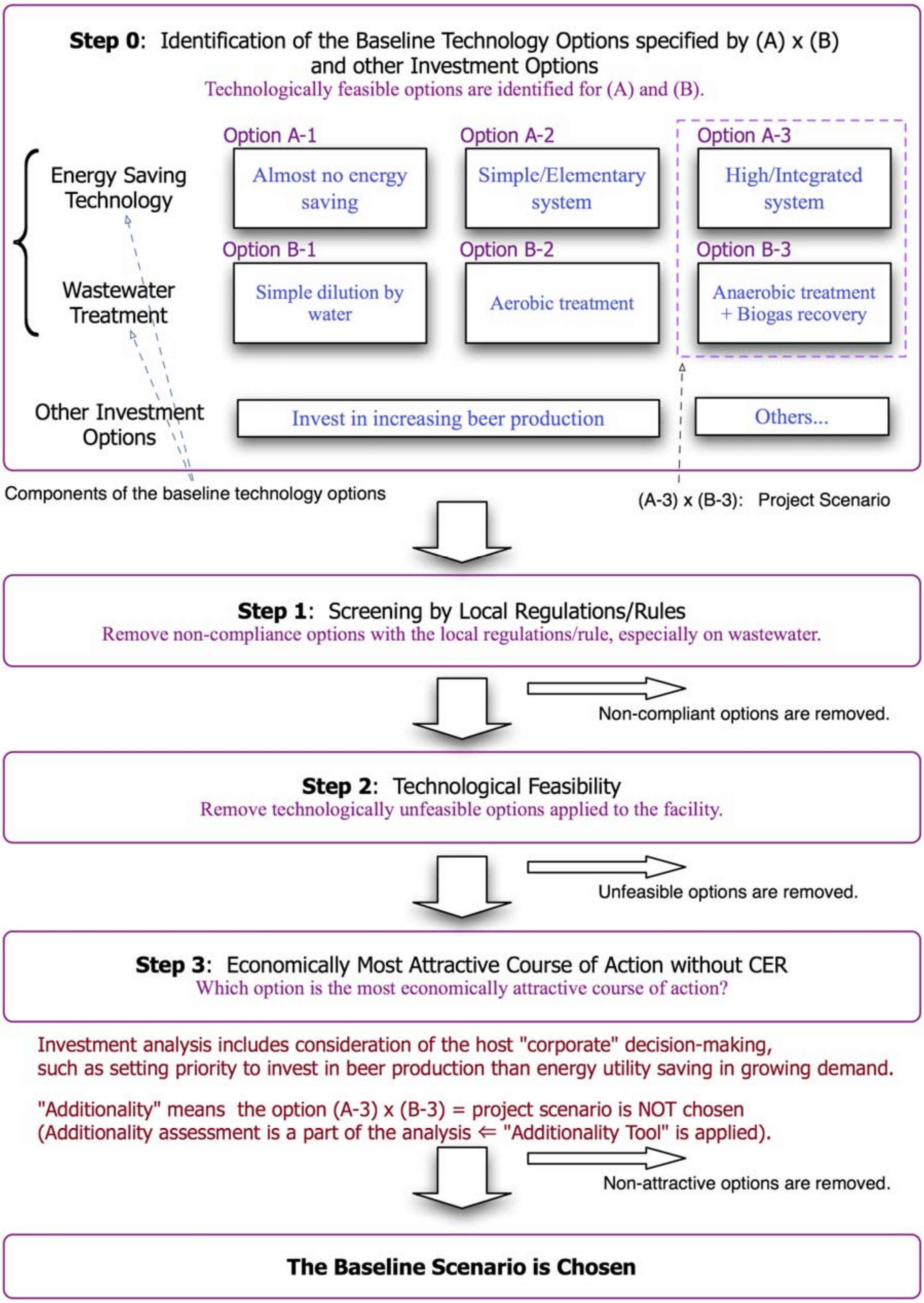


Figure NMB-3: Steps to Identify the Baseline Scenario and Demonstrate Additionality

[Step 1] Screening by local regulations/rules

- **Can the facility comply with local regulations for wastewater?**

  [Explanation] The answer to this question depends on the status quo of the wastewater treatment system. Especially for Option B-1, the additional burden on environment by increasing beer production plan should be considered.

  The beer production expansion plan and the outlook of the wastewater pollution level information should be provided as the supportive information.

The baseline scenario should be "Yes" for [Step 1]. The options for "No" cannot be the baseline scenario.

[Step 2] Technological feasibility

- **Is the energy saving technology feasible to be applied to the facility?**

  [Explanation] Based on the applicability condition 4, Option A-3 may not be feasible qualitatively. However, a cost assessment [Step 3] is needed to confirm this conclusion.

  Status data on the technology choice of the host country brewery sector should be provided as supportive information by the project participants.

The technology used in the baseline scenario should be "Yes" for [Step 2]. The technological options for "No" cannot be used the baseline scenario.

[Step 3] Economically most attractive course of action without CER

- **Which option is economically the most attractive course of action?**

  [Explanation] Considering the 'integrated' system of energy saving and waste water treatment, a cost/benefit assessment is needed to choose the unique baseline scenario because energy saving technology in Option A-3 includes biogas utilization from anaerobic treatment of waste water.

  If the cost implication is almost the same for some options, [Step 2] regarding technology penetration in the host country is used to choose the level of technology as the more feasible baseline scenario.

  A cost assessment should be provided by the project participants to the validator (Operational Entity) with suitable supportive information/evidences. Such information includes:

    - *Identification of the indicator(s) which is (/are) used for investment decision-making (e.g., pay-back period, IRR, …); and*
    - *Calculation of such indicators,*

  with suitable supportive information which includes:

    - *beer production plan;*
    - *sensitivity analysis for key assumptions;*

- *similar investment decision-making records (with the reasons)*[5] *of the host company in the past, if available; and*
- *how these are differentiated between existing and additional facilities, if needed.*

Steps provided by the "Tool for the demonstration and assessment of additionality" prepared by the CDM EB can be applied [Step 2 (Investment Analysis), Sub-step 2a (Determine appropriate analysis method), Sub-step 2b (Option II: Apply investment comparison analysis, Option III: Benchmark analysis), Sub-step 2c. (Calculation and comparison of financial indicators), and Sub-step 2d. (Sensitivity analysis)].

In addition, even if some energy saving option is regarded as economically attractive in itself (e.g., by using IRR calculation), it is needed to assess whether such an option is the MOST economically attractive among other investment options other than energy saving within the limited financial resources. In some case, especially rapid growth of beer demand is expected, investment on increasing beer production may be prioritized in corporate decision-making, i.e., chosen as the most economically attractive course of action. If this is the case, the project participant(s) shall provide documented information/evidences/analysis for its demonstration.

In addition, if the host company's investment criteria include some "non-cost" components such as governmental public policy beyond economical attractiveness, such factors are to be considered and judged by the validator (Operational Entity).

The baseline scenario should be the most economically attractive course of action which passes [Step 1] and [Step 2]. Other options cannot be the baseline scenario.

Baseline Scenario

Through these steps, under the applicability conditions (section A-3), especially

Condition 4:

A high-energy efficient system is not installed at the factory now and not commonly installed in the host country beer brewery sector [*i.e.*, lack of experience and knowledge].

Condition 5:

Reduction of energy costs by the project (through energy saving) is not the most economically attractive course of action to invest without CER revenue.

The technological aspect of the **baseline scenario** is concluded as

- **Utilizing current level of energy saving system (which may include the simple energy saving technology for relatively expensive fuel (*e.g.*, heavy fuel oil boiler case)), and**
- **Continuation of current practices**[6] **for wastewater treatment until increasing beer production capacity which may result in non-compliance of the local environmental**

[5] Not only decision-making for investment, but also for non-investment are good information. If written records are not left, the decision-makers of the host company's investment shall accept the interview by the validator for the past experiences.

[6] In some case, aerobic wastewater treatment is used as the current practice.

regulation. After the threshold production capacity level, aerobic wastewater treatment system is applied.

In some cases, expansion of the beer production would be invested as well as the baseline (*i.e.*, identified as the most attractive course of action).

Even if we observe introduction of some incentive framework in the future to promote energy saving, it does not alter the baseline scenario mentioned above considering its "Type E–" nature of the host country's policy.

For the wastewater treatment system in the baseline scenario, a lagoon system is used only if the existing facility utilizes a lagoon system. In this case, biogas CH_4 reductions from the project is counted on (before expanding the capacity of the beer production facility), while in other cases, such a reduction is not claimed as CERs because of (a) technical difficulties in monitoring, (b) almost no methane emissions under the aerobic condition, and (c) conservative estimation method for the baseline emissions.

It is apparent that the emission level in the baseline scenario (less energy efficient scenario) is larger than that of the project scenario. Therefore, the project is "additional".
(Steps to demonstrate additionality are embedded in the steps to identify the baseline scenario by confirming that the project activity cannot be the baseline scenario).

D.2. Criteria used in developing the proposed baseline methodology:

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The characteristic feature of the methodology is to categorize the energy saving level by using the technological aspects (*i.e.*, integrated system, elementary technology, or almost none). Among them, efficiency improvement is incorporated as the beer production increases for reflecting the real situation and conservativeness.

The principal criterion to choose the baseline scenario is economic consideration for investment. In addition, some screening tests are added to meet local regulations (for wastewater treatment) and feasibility of the technologies.

In order to elaborate the mathematical formula of the baseline emissions, the key is how to estimate the specific energy consumption (energy intensity). This methodology develops a parameter-fitting method to approximate the intensity in the counter-factual baseline scenario.

D.3. Explanation of how, through the methodology, it can be demonstrated that a project activity is additional and therefore not the baseline scenario (section B.3 of the CDM-PDD):

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In section D.1., the procedures to identify the baseline scenario is provided.

It includes the project scenario as one of the baseline scenario option ((A-3)×(B-3)) and shows that this project is not chosen as the baseline scenario.

It is apparent that the emission level in the baseline scenario (less energy efficient scenario) is larger than that of the project scenario. Therefore, the project is "additional".
(Steps to demonstrate additionality are embedded in the steps to identify the baseline scenario by confirming that the project activity cannot be the baseline scenario).

Therefore, it is demonstrated that a project activity is additional and not the baseline scenario through the procedures/steps shown in section D.1.

D.4. How national and/or sectoral policies and circumstances can been taken into account by the methodology:

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Basically, this methodology is applied to any non-Annex I countries without advanced energy efficient systems in the beer brewery sector in which the applicability conditions in section A.3. can be applied.

D.5. Project boundary (gases and sources included, physical delineation):

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The project boundary is defined as the associated facility site (where the energy conservation technologies are applied with waste water treatment system) and the electricity supply system (power grid or privately-owned generator) connected to it (see Figure NMB-4).

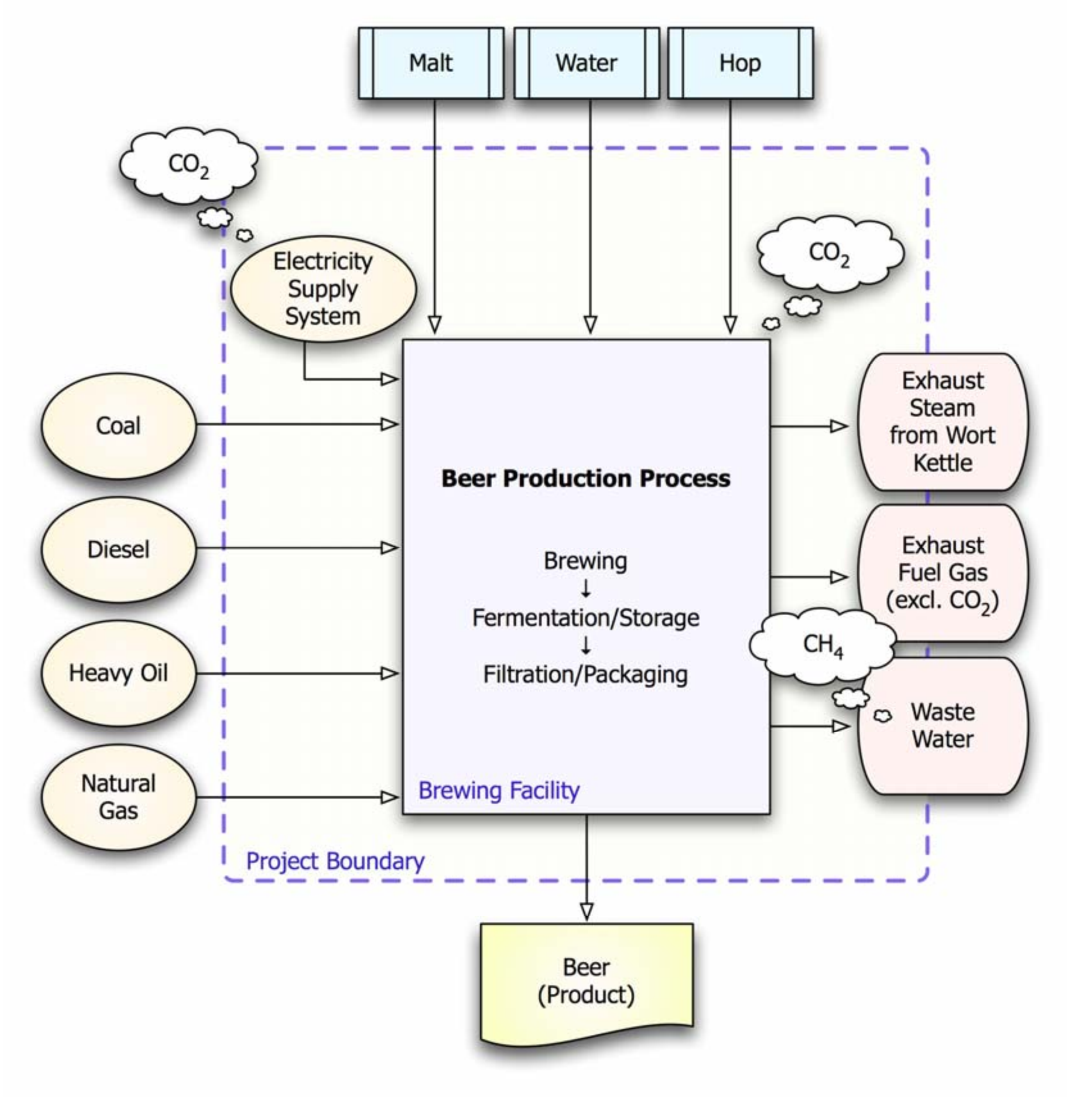

Figure NMB-4: Project Boundary for Brewery Plant Energy Conservation Project

In above figure (NMB-4), the vertical flow shows the production process for beer from raw materials to final product, necessary utilities and emissions are shown by horizontal lines.

The related GHGs by source is categorized in the following table:

		Within the Project Boundary	Outside of the Project Boundary
Baseline Scenario	*Major emissions (to be monitored)*	▪ Fossil fuel combustion for heat/steam (CO_2) ▪ Fossil fuel combustion for internal power generation (CO_2,) ▪ Fossil fuel combustion at the external power grid (CO_2)	*none*
	Minor emissions (no need to be monitored)	▪ Fosssil fuel combustion (heat and electricity) (N_2O) ▪ Transportation of fuel (CO_2) ▪ Gaseous effluent (CH_4)	▪ Macroeconomic effects (CO_2)
Project Scenario	*Major emissions (to be monitored)*	▪ Same as those of Baseline Scenario	*none*
	Minor emissions (no need to be monitored)	▪ Same as those of Baseline Scenario	▪ Same as those of Baseline Scenario

The emissions categorized as "minor emissions" are far below the uncertainty level of the emission reductions. Therefore it is rational to exclude them from the calculation and monitoring items.

D.6. Elaborate and justify formulae/algorithms used to determine the baseline scenario. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

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Here we assume that the anaerobic lagoon system is not used for wastewater treatment system of the beer production facility. The lagoon case is explained at the end of this subsection.

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

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

where

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

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

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

$EQ^{[electricity]}_i$: lager-equivalent energy consumption factor for electricity,

$EQ^{[heat]}_i$: lager-equivalent energy consumption factor for heat,

$SEC^{BL}_{k,y}$: specific energy consumption rate (energy intensity) of the baseline scenario [kcal/kL-beer] of the energy type *k* (such as external electricity, diesel oil, heavy oil, *etc*),

$CEF_{k,y}$: CO_2 emission factor of energy *k*

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

$Q_y^{[\ ]} = \sum_i Q_{i,y} * EQ^{[\ ]}_i$ is the annual production of beer at the facility [kL-beer/yr] calculated by using "lager-eq. (for electricity)" and "lager-eq. (for heat)", *i.e.*, adjusted one of the beer production.[7] 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 (if the beer production capacity increase scenario is not chosen as the baseline scenario) and monitored *ex post*. $EQ^{[\ ]}_i$ is estimated using technical consideration prior to implementation of the project and assumed to be constant.

In case beer production capacity increase scenario without energy efficiency improvement chosen as the baseline scenario (*i.e.*, identified as the economically most attractive course of action without the CER revenue) is, $Q_{i,y}$ is replaced as $Q^{PLAN}_{i,y}$ as planned, if and only if appropriate and sufficient documented evidences are provided by the project participants. The DOE (validator) assesses the appropriateness of such evidences considering the related data/information which may support such a plan. If the DOE finds that such information is insufficient, $Q_{i,y}$ is set to be common for the baseline scenario and the project scenario as the conservative estimation.

Summation over *k* is for the fuel for heat part; and electricity and fuel for power generation for electricity part) [tCO_2/kcal or tCO_2/t-fuel, tCO_2/l-fuel] consumed in the facility (measured annually). It is noted that $Q_{i,y}$ and $SEC^{BL}_{k,y}$ are monitored and estimated *monthly* basis.[8]

Estimation of $SEC^{BL}_{k,y}$

It is not straightforward to estimate the specific energy consumption rate $SEC^{BL}_{k,y}$ of the counterfactual baseline scenario using the measurable parameters (in the project scenario) as it is too naïve to set $SEC^{BL}_{k,y}$ as a constant (*i.e.*, independent of beer production). $SEC^{BL}_{k,y}$ is approximately regarded as a function of the (lager-equivalent) beer production. For higher production[9] period, $SEC^{BL}_{k,y}$ is expected to be lower even though the same production process is used.

[7] 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 "lager-equivalence" concept (no need to specify "lager", while some typical type of beer is set for the basis). As "lager-equivalence" concept may be different for electricity and heat consumption, the lager-equivalent beer production has two different ones such as $Q_y^{[Electricity\text{-}eq]}$ and $Q_y^{[heat\text{-}eq]}$.

[8] 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 mathematically strict expression.

[9] Theoretically, another parameter such as capacity utilization rate relative to optimal operation may provide better approximation. However, we choose beer production level (adjusted by lager-equivalence) for ease to handle.

In general, two forms of energy, *i.e.*, electricity and heat, specify the energy used in the facility. Therefore, we develop the specific energy consumption rate of the baseline scenario for electricity and heat use.

Electricity is obtained by in-house power generation and purchase from a grid. Heat may be generated by plural fuels (simultaneously or chronologically). Associated specific energy consumption rates are named $SEC^{BL}_{electricity,y}$ and $SEC^{BL}_{heat,y}$ while these are subject to $SEC^{BL}_{k,y}$ (not independent parameters).

Here we develop a parameter-fitting regression analysis method which well approximates this counterfactual specific energy consumption rate by measurable parameters as accurately as possible.

The procedures are as follows (differentiated by data availability):

1. Collect the historical monthly[10] data on beer production, fuel consumption, and electricity consumption of the project site prior to the project as long as possible.

   If plural fuels are used, those are aggregated as steam equivalence. The fuel mix ratio is assumed to be the same as in the project scenario.

   For electricity consumption, in-house power generation and purchase from a grid will be aggregated. The amount of in-house power generation is assumed to be the same as that of the project scenario if the project does not install new power generation system. If the project installs such generation system, beer production level adjusted in-house power generation is assumed based on the latest 18 months performance.

   The latest monthly data until the project's implementation shall be archived for future use (even after finalizing the PDD).

   Expert judgment can be used to exclude some specific data which may result from error or specific monthly situations (such as long blackout). The DOE reviews the appropriateness of this expert judgment.

2. Plot the points with coordinate specified by (beer production, specific fuel consumption) and (beer production, specific electricity consumption) in a graph in order to estimate baseline specific energy consumption rate in the future using regression analysis.

   The regression method is as follows:

   Step 0:

   Categorize the products into the level of energies used per kL. Technological consideration is made to convert the products into a typical one, say e.g., "lager-equivalence". The volume of the beer produced by the facility is converted to this "lager-equivalence" (for electricity and fuel use (heat), separately), i.e., using "lager-eq. (for electricity)" and "lager-eq. (for heat)".

   Step 1:

   Plot (beer production, specific fuel consumption) and (beer production, specific electricity consumption) in a graph and fit the points by exponentially declining function to a certain level using regression tool of a spreadsheet. An example is shown below.

   Step 2:

[10] Beer production differs very much by month because the demand depends on temperature, *etc*. This implies that the specific consumption rates differ very much by month as well.

Assess the regression formula on the approximation. If the project participants find some correction or adjustment incorporating the specific situation of the facility, such correction may be applied. Those corrections may include:

- *Instability of the electricity supply from the grid or self generation;*
- *Change of product-mix. Electricity and fuel consumption may be different for different products such as lager, stout, etc; and*
- *Theoretical findings regarding the technology used.*

  (1) In many cases, fuel consumption and electricity consumption are independent, while if the technology allows use of electricity as an alternative to fuel, correction due to such mixing may have an influence; and

  (2) We set "$y = A e^{-\lambda x} + B$" type exponentially declining function to fit (x: beer production) as the proxy declining function. Here "B" is the ultimate (theoretically lowest) specific consumption rate obtained by theoretical and technological consideration of the process. Or "B" is set as the second best[11] latest historical performance more than 18 months times 90% as the alternative to the theoretically lowest one if such theoretical consideration is difficult. If such data are not available, B is set zero.

- *If the available data cannot provide a significant conclusion statistically, data for other cases which utilize very similar technologies and similar fuel are assessed whether to provide better results.*

Step 3:

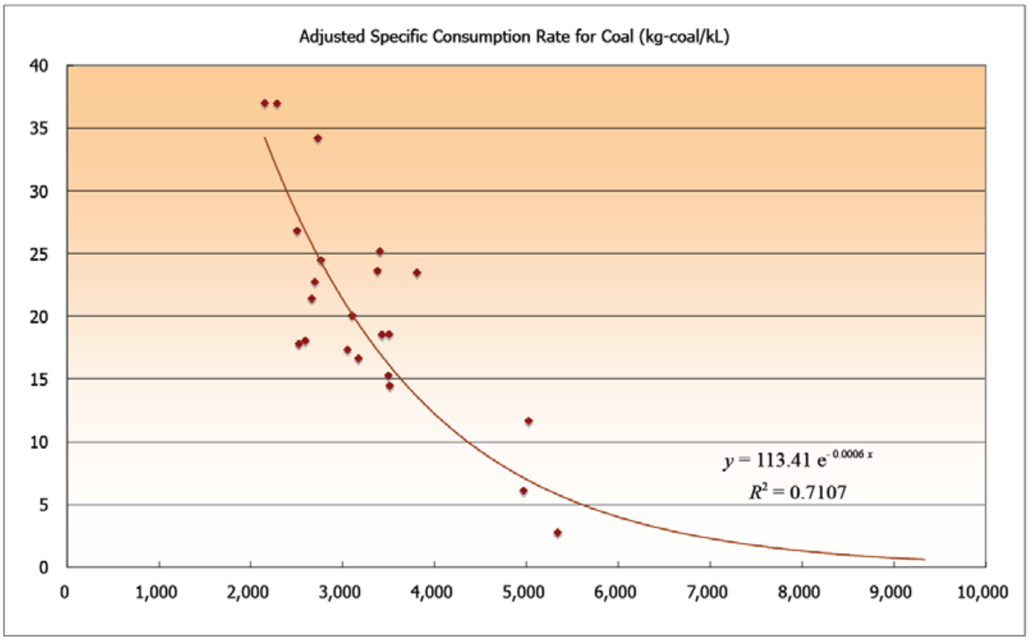
Consult with an authority[12] which well knows the technologies and situation of the beer industry of the host country. This consultation includes the judgment whether such formulae well approximate the host country brewery sector's situation taking into the conservativeness into account as well.

3. Develop $SEC^{BL}_{electricity,y}$ and $SEC^{BL}_{heat,y}$ as a function of monthly beer production.

   This process shall be done before implementation of the project. The function is applied for whole of the crediting period. At renewal of the crediting period, applicability conditions as well as assessment of specific energy consumption are to be done.

[11] The reason why we choose "the second best" is that we may find some singular month if we choose the best one, so the best one may not represent the "true" situation. 90% is chosen for conservativeness.

[12] Locally, RIB (Research Institute of Brewing) for Vietnam case, for example.



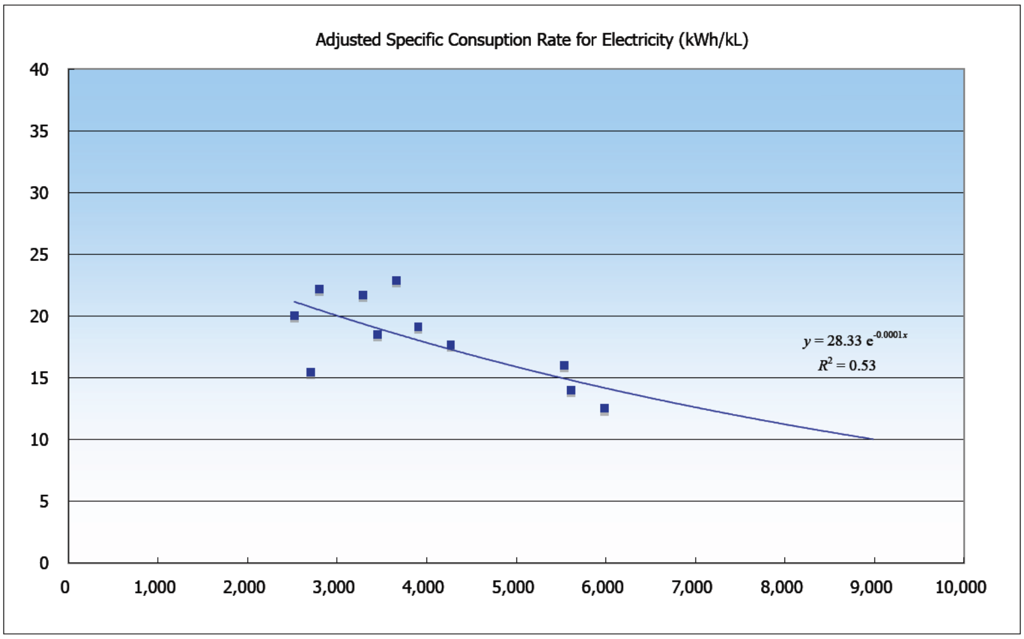


Figure NMB-5: An Example of Regression Analysis (horizontal axis: kL)

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

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

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

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

$$SEC^{BL}{}_{electricity}{}^{GRID}{}_{y} = SEC^{BL}{}_{electricity,y} - SEC^{BL}{}_{electricity}{}^{INT}{}_{y}$$

where $SEC^{BL}{}_{electricity}{}^{INT}{}_{y}$ *is that of internal (in-house) power.* $SEC^{BL}{}_{electricity,y}$ *is estimated as above.*

If the project does not install new power generation system, it is reasonable to assume that $Q_y * SEC^{BL}{}_{electricity}{}^{INT}{}_{y}$ *is common (=*$Q_y * SEC^{PJ}{}_{electricity}{}^{INT}{}_{y}$*) for baseline and project scenarios, therefore*

$$SEC^{BL}{}_{electricity}{}^{GRID}{}_{y} = SEC^{BL}{}_{electricity,y} - SEC^{PJ}{}_{electricity}{}^{INT}{}_{y}$$

where $SEC^{PJ}{}_{electricity}{}^{INT}{}_{y}$ *(=*$Q\_Energy_{InternalElectricity,y} / Q_y{}^{[Electricity\text{-}eq]}$*) is that of the project scenario.*[13]

If the project installs power generation system, beer production level adjusted in-house power generation is assumed based on the latest 18 months performance to estimate $SEC^{BL}{}_{electricity}{}^{GRID}{}_{y}$*:*

$$SEC^{BL}{}_{electricity}{}^{INT}{}_{y} = (Q_y{}^{[Electricity\text{-}eq]} / Q^{[Electricity\text{-}eq]}{}_{0}) * SEC^{BL}{}_{electricity}{}^{INT}{}_{0}$$

where the parameter with suffix "0" *is the average of the latest 18 months before implementation of the project. Therefore,*

$$SEC^{BL}{}_{electricity}{}^{GRID}{}_{y} = SEC^{BL}{}_{electricity,y} - (Q_y{}^{[Electricity\text{-}eq]} / Q^{[Electricity\text{-}eq]}{}_{0}) * SEC^{BL}{}_{electricity}{}^{INT}{}_{0}$$

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

(5. Calculate monthly baseline CO_2 emissions by using the beer production value *ex post*.)

<u>Estimation of $CEF_{k,y}$</u>

For the carbon emission factor of the energy sources, internal fuel use is straightforward. Local data are to be measured or those provided by the fuel supplier.[14] This includes fuel consumption used in self-power generation.

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

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

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

In this kind of energy saving projects, the associated grid electricity displacement effect is negligible in comparison with the capacity of the connected grid (set as an applicability condition).

Therefore, the build margin weight factor w^{BM} can be regarded as zero.

The methodology sets a procedure to *confirm* this by interviewing person(s) responsible for the grid power development plan before start of implementation of the project.

As for the identification of operating margin plants (or plant-type(s)), the methodology includes

13 It should be noted that $SEC^{PJ}{}_{electricity}{}^{INT}{}_{y}$ is obtained by the fuel use for in-house power generation.

14 The methodology tries to find out the most accurate value. Therefore, the IPCC default values are not used in principle, instead, the local supplier's data or direct measurement by sampling is used.

- the calculation methods specified in the consolidated methodology for renewable power plants connected to the grid (ACM0002),
- identification of the marginal plants by interview with the grid operator(s),

The priority for choosing the method above is to use the local data as precise as possible (dependent on data availability), unless the project participants choose the most conservative method (the weighted average of all power plants connected to the grid). The second one may reflect very site-specific situation, thus preferable.

Through these interviews of the appropriate persons of the grid, the project participants shall provide the information on

(1) No build margin component:

- Confirmation with the signature of the power development division people.

(2) Operating margin component:

- Identification of marginal plant(s) or plant type(s).

  In some cases, such plants may be different from month to month or by physical location of the project.

- The reason and data why such plants are chosen.
- Confirmation with the signature of the grid operation division people.
- Identification of the plants shall take the data availability into consideration in order to calculate the *CEF* (= fuel use * carbon coefficient of the fuel / power supplied to the grid) year by year.

Estimation of methane emissions in the baseline scenario

If an anaerobic lagoon system (which emits methane) is used for wastewater treatment before implementation of the project, the methodology concludes that such treatment system is to be used until the beer production capacity is added. Therefore, until that time (monitored *ex post*), methane is considered to be emitted in the baseline scenario.

There are several methods to monitor methane emissions from lagoons with anaerobic conditions which are categorized in the IPCC GHG Inventory Guidelines and Good Practice Guidance:

(1) Tier 3: Direct measurement

(2) Tier 2: (Total organic waste) × (country specific emission factor)[15]

(3) Tier 1: (Total organic waste) × (IPCC default emission factor)

IPCC Guidelines suggests to use Tier 3 than Tier 2 or Tier 1, as Tier 3 is the most accurate.

In this case, direct measurement has two methods:

(a) *Ex post* direct measurement of the captured biogas, and

(b) *Ex ante* direct measurement of the facility before implementation of the project.

[15] Emission factor = (Maximum methane producing capacity (kg-CH_4/kg-BOD or kg-COD)) × (Weighted average of methane conversion factors).

It is not straightforward to say that the captured amount of biogas using the method (a) is identical to the released biogas without the project. It is rather also difficult to develop a method to determine the relationship (correction factor) between the two.

On the other hand, method (b) is rather straightforward in that it adjusts the total organic waste disposed. Other factors such as maximum methane production capacity and methane conversion factor are regarded as the same for these two cases (before implementation of the project and the baseline scenario).

We apply therefore the (b)-type direct measurement method (measured *ex ante*) corrected by the total organic waste (measured *ex post*).

This part is given by

$$BE_y^{\mathrm{BioGas}} = BioMethane^{\mathrm{before}} * (OrganicWaste_y \,/\, OrganicWaste^{\mathrm{before}}) * \mathrm{GWP\_CH_4}$$

where $BioMethane^{\mathrm{before}}$ is the annual emission of biogas-based methane measured before implementation of the project, $OrganicWaste^{\mathrm{before}}$ is the annual organic waste measured in the same period as $BioMethane^{\mathrm{before}}$. $OrganicWaste_y$ is the annual organic waste in a given year y after implementation of the project. Details of the measurement are given in the monitoring methodology. $\mathrm{GWP\_CH_4}$ (= 21) is the global warming potential with a 100-year time horizon specified in the IPCC Second Assessment Report by the end of the 1st Commitment Period.

It should be noted that these emissions are applied *before* expanding the beer production capacity of the existing plant only.

D.7. Elaborate and justify formulae/algorithms used to determine the emissions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

>>

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

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

where Q_y is the annual production of beer of the facility [kL-beer/yr], $SEC^{\mathrm{PJ}}_{k,y}$ is the specific energy consumption rate (energy intensity) of the project scenario [kcal/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/kcal or tCO_2/t-fuel, tCO_2/kL-fuel] consumed by the facility (measured annually).

$Q_y * SEC^{\mathrm{PJ}}_{k,y} = Q\_Energy_{k,y}$: consumption of energy source k.

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

D.8. Description of how the baseline methodology addresses any potential leakage of the project activity:

>>

The possible leakages outside the project boundary are:

1. Effect of methane emissions from effluent;
2. Effects of fuel transportation-related CO_2;

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

Here we try to assess these leakages as follows.

1. With regard to methane from effluent, there is no significant difference between the baseline scenario and the project scenario because both scenarios do not emit methane (aerobic treatment for baseline scenario and bio-gas utilization for project scenario) after increasing of the beer production capacity. Even if small correction is needed, the difference between them is higher order infinitesimal, thus judged to be negligible. Before increasing the beer production capacity, methane part from effluent in the baseline emissions are higher than that in the project emissions. Therefore, neglecting such emissions is a conservative estimation.
   Strictly speaking, this is within the boundary, so it is not categorized as the leakage.
2. Fuel use is reduced by the project, thus neglecting such CO_2 a conservative estimate, even though such amount may be minor.
   Strictly speaking, this is within the boundary, so it is not categorized as the leakage.
3. 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.
4. By implementing this project, the macroeconomic effect of increased sales volume for the beer produced in this plant can be expected due to improved competitiveness, in theory. However, it is expected that the demand for beer in the host country is identical for both baseline and project scenarios. This plant will only replace the sales of other brewery companies. The plant which implemented this project will obtain higher energy efficiency compared to other brewery plants in the host country. Therefore, GHG emission per unit of beer sales volume is expected to be low and the macro-economic effect is negligibly small as well as it can be discarded in a conservative manner.

Therefore, we do not take such leakage effects into account as monitoring items.

D.9. Elaborate and justify formulae/algorithms used to determine the emissions reductions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

>>

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

$$ER_y = BE_y - PE_y$$

as specified in D.6 and D.7 (as the leakage effects are negligible).

SECTION E. Data sources and assumptions:

E.1. Describe parameters and or assumptions (including emission factors and activity levels):

>>

The external parameters used in the methodology are

- Carbon emission factor for each fuel (including energy content of the fuel), and
- Carbon emission factor of external electricity

which are not measured on-site.

The most important assumption used in the methodology is that the parameter-fitting regression analysis provides significant results, *i.e.*, specific energy consumption rate as a function of beer production. This is checked by a beer authority.

Other assumptions:

If plural fuels are used, the fuel mix ratio is assumed to be the same as in the project scenario.

For electricity consumption, the amount of in-house power generation is assumed to be the same as that of the project scenario.

E.2. List of data used indicating sources (e.g. official statistics, expert judgement, proprietary data, IPCC, commercial and scientific literature) and precise references and justify the appropriateness of the choice of such data:

>>

Carbon emission factor of each fuel (including energy content of the fuel):

Provided by local fuel supplier or measurement by sampling.

Carbon emission factor of the external electricity:

Confirmation that the pure operating margin concept is applied by interviewing the person responsible for power development planning.

Identifying marginal plant(s) or type(s) of plants is judged by the local grid operator(s), taking the data availability into consideration as well or calculated by using the statistical data of the power company which owns the grid.

E.3. Vintage of data (e.g. relative to starting date of the project activity):

>>

Ex ante data are collected for

- Beer production
- Energy consumption by source, and
- Methane emission from anaerobic lagoon (if needed).

These are monthly data for at least more than one year. If the data are not available for such a long period, limited data with some correction using the IPCC method on GHG Inventory shall be used. The appropriateness of such correction shall be judged by the validator (operational entity).

Other parameters are monitored *ex post* (latest data are used at that time).

E.4. Spatial level of data (local, regional, national):

>>

The methodology tries to use the local data as much as possible. If some default factor is used, such factor is adjusted by a correction factor incorporating the local specifications.

SECTION F. Assessment of uncertainties (sensitivity to key factors and assumptions):

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The key uncertainty associated with the estimation of baseline emissions relies on the specific energy consumption rate $SEC^{BL}_{k,y}$ of the baseline scenario.

(1) The consumption pattern of energies used will vary depending on the expansion of the beer production capacity year by year in the counter-factual baseline scenario. The methodology tries to approximate such consumption pattern of plural energies by giving the specific formula taking real beer brewing processes into account.

(2) Correction may be needed for baseline emissions if products other than beer are produced. In this case, the baseline calculation method will be modified accordingly by evaluation of the influence of energy consumption for producing products other than beer. Here we avoid this case by limiting energy use by such non-beer production to less than [5%] of total energy consumption in the applicability condition or applying correction in the regression analysis which is judged by a beer authority.

(3) The baseline emissions will change greatly when there is a major change in beer production process. In other words, starting production of a beer with different process accompanied by a significantly greater energy consumption rate during the crediting period. For such a case, the project site enterprise will confirm the possibility of changing beer production process significantly prior to adaptation of this methodology. It is also planned to review the methodology in 10 years after commencement of the project and necessary modifications will be applied at that time accordingly.

In addition, CEF_{coal} may be one of the large sources of uncertainty because of the variety of quality even if categorized in a same grade. Therefore, the monitoring methodology measures dispersion of data as well as regular sampling (see NMM).

For methane emissions from wastewater treatment system, methane is assumed to be emitted from the anaerobic lagoon in the baseline scenario prior to expansion of beer production capacity only. This assumption is conservative because it neglects the case after increasing beer production capacity. If a non-lagoon type wastewater treatment system is used, it is technically very difficult to estimate methane emissions from an open-type treatment system, thus no CERs are claimed for this case.

Other uncertainties, such as those which come from the CO_2 emission factor of (grid) electricity generation, are minor.

The effects of CO_2 emissions from fuel transport can be regarded as negligibly small because such amount is much smaller than the uncertainty level of the key parameters mentioned above.

SECTION G. Explanation of how the baseline methodology allows for the development of baselines in a transparent and conservative manner:

>>

The methodology tries to figure out the specific energy consumption rates by depicting the regression curve which describes future possibility to expand beer production capacity.

The methodology tries to maintain objectivity and accuracy by incorporating external expert judgments, such as those of beer authorities (appropriateness of the regression analysis), local power development planners (confirmation of no build margin), and local grid operators (identification of marginal plant(s)), as well as the validator (operational entity).

ANNEX. Technical outline of the beer brewing process and its energy use as a utility

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 ^{o}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 heat exchanger and transferred to fermentation tanks. Yeast is then added to converts the sugars into alcohol and carbon dioxide gas at 5 to 8 ^{o}C until stopping fermentation at around 4 ^{o}C. Green beer is created after removing yeast, then matured at about 0 to –1 ^{o}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 ^{o}C 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.

Applicability Condition 1 (beer production development):

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

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

(2) modification of the existing energy utility system by installation of additional line for the bottleneck beer production process (*e.g.*, brewing process. See the figure below for an image), or

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

The second and third cases are those which this methodology is applicable. The first approach is outside of the scope of this methodology.

[The figure below shows an example that one of the processes (brewing process) is the bottle neck to increase beer production, while no need to construct new energy utility system (case (2) above)]

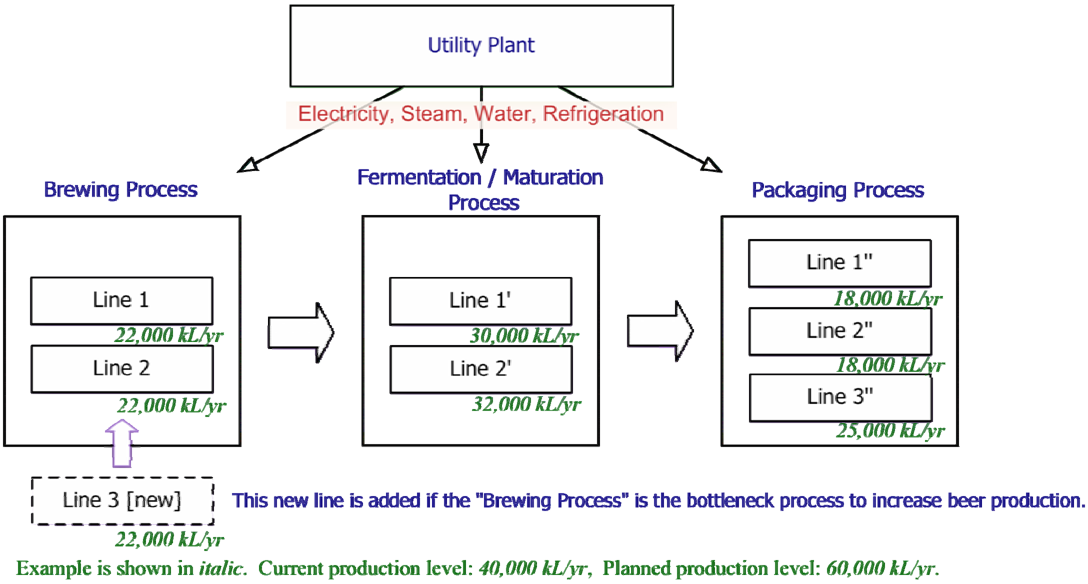

Figure NMB-6: How the "Line" is added in the brewery under the growing demand

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