CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)
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CONTENTS

SECTION A. Identification of methodology

A.1. Proposed methodology title:

Baseline methodology for energy integration project activities involving energy efficiency, self-generation, and/or cogeneration measures at an industrial facility

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

The UNFCCC CDM web site does not provide a list of categories of project activities, from which one might choose the ones applicable for this proposed new methodology.

If one were to use the "Sectoral Scope" classification as applied to Designated Operational Entities, possible categories might be: (3) Energy demand or, since the project activity is developed at an industrial facility, (4) Manufacturing industry or (5) Chemical industry.

A more specific category of project activity might be "industrial energy integration involving energy efficiency, self-generation, and/or cogeneration."

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

This methodology is applicable under all of the following conditions:

1. The project activity involves an energy integration aimed primarily at energy efficiency in industrial facilities that produce only one product, where different mitigation options can be included:
   - Changes in the energy efficiency of any equipment (fuel and electricity savings),
   - Addition of electricity self-generation equipment or changes in electricity self-generation equipment,
   - Addition of electricity cogeneration equipment or changes in electricity cogeneration equipment.

   Energy integration refers to a set of interrelated technological options that generates improvements in fuel usage, in the management of electricity, and in the overall production process, giving rise to a better energy efficiency leading to fuel and/or electricity savings (i.e. to take advantage of surplus energy from a part of a process to be used in other part). The improvements can be achieved, for example, through equipment replacement or adaptations, development and incorporation of more advanced technologies, partial redesign of some processes, better use of process heat (which can be used for additional energy generation), etc.

2. The production processes at industrial facilities involve variables that are difficult to predict and where an individual monitoring of equipment turns out to be impractical. In such processes are those in which the operation and energy use conditions change frequently in an unscheduled way, making it almost impossible to determine a one-to-one correlation between energy fluxes and consumption patterns. An example of such processes is a petrochemical facility where steam can be provided by different sources, such as boilers, exothermal reactions, waste heat, etc., depending on operating conditions.

   For such production processes, the baseline is determined from data representing different operation and energy use conditions. In this methodology, the baseline fuel consumption is determined by

correlating fuel consumption with production (output) of the industrial facility. In the same way, baseline electricity purchase/sale is determined by correlating electricity purchase/sale with industrial output. Accordingly, it is required that equipment giving rise to an eventual interdependence between fuel consumption and electricity purchase/sale can be identified, and their effects separated, in such a way that fuel consumption and electricity purchase/sale are independent variables, removing the constraints among them, if any.[1] Otherwise this methodology is not applicable.

This includes, for example, the case of existing equipment consuming steam from boilers (burning fuels) for producing electricity (e.g. using a turbo-steam generator) that is converted to mechanical energy by other equipment. It is required that the operating modality of this equipment (on/off) is not affected by the project activity, in order to assume that this operating modality is the same for both, the baseline and project scenarios.[2]

Once correlations are established, baseline fuel consumption and electricity purchase/sale are obtained from these correlations, based on production recorded following project implementation (*quasi*-dynamic baseline).

The above mentioned relations result from averaging a large number[3] of dispersed values not corresponding to a particular operating condition, combination or type of fuels, ratio of fuel or electricity, or equipment efficiency. They must be represented by curves with a statistical basis (see the statistical method provided in Section F). Thus, for such processes it is necessary to have sufficient data available to determine representative average curves, in which the average global performance of the plant for a determined value of the production does not depend on the details of how the industrial plant is operated.[4]

3. Project activities where the continuation of current practice is not prevented by any circumstance.

[1] When monitoring data allow one to determine the electricity component of baseline emissions in a straightforward manner the sophisticated statistical curve method can be avoided. This happens, for example, when the current practice does not involve on-site electricity generation, which is added by the project activity. In that case, avoided power-grid CO_2 emissions are directly obtained as the amount of electricity generated by the new generation equipment (see Section D.6).

[2] This situation might occur when electricity and fuel prices are competing, thus influencing company's decision regarding the operation mode of the turbo-steam generator at the industrial facility. In this case the relations are split in two families of curves, depending on whether the turbo-steam generator is used or not during a given day, week, or month. The parameter that should be monitored in this case is the whether the turbo-steam generator is operating or not (see Section D.6).

[3] This methodology establishes that in order to have a robust set of values that can be correlated through statistical methods (see Section F) a three-year data vintage must be used considering daily, weekly, or monthly (according to data availability) historical values of the relevant variables (fuel consumption, electricity purchase/sale, and production).

[4] A three-year data period shall be used to collect historical data. The methodology requires that these data cover a wide range of production level at the industrial facility to have the possibility of relating a given monitored value of production with the corresponding value of production in the baseline, from which the corresponding energy value is obtained. In order to avoid values that fall out of the historical range, the production capacity of the industrial facility cannot be enlarged, unless the emission calculation is not based on the historical curve approach (the case mentioned in footnote 1). If, even under this condition, the production value monitored following project implementation falls out of the historical range (e.g. in the past the facility has never reached full capacity peaks), an extrapolation of the fitting curve can be used until the maximum production reachable with the existing capacity.

This methodology shall be used in conjunction with the accompanying monitoring methodology submitted together with this proposal.

This methodology is thus limited to emissions related to fuel consumption at the industrial facility and to emissions related to electricity generation outside the industrial facility. The emissions related to electricity generation may be produced either from isolated power plants serving the facility or from power plants belonging to the grid where the facility is connected. It does not include GHG not related to the sources mentioned above.

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

The potential strengths of the proposed new methodology include the following:

- It is applicable to several types of project activities
- It is straightforward to apply and relies on what should be readily available and verifiable data
- It is built on approved methodologies
- It is adequate for processes involving variables that are difficult to predict

A weakness of this proposed methodology is the necessity of intensive energy and production data recording.

SECTION B. Overall summary description:

The methodology first analyzes the baseline determination, by showing that the continuation of current practices at the industrial facilities would have occurred as the most likely scenario, through an analysis of legislation and national and/or sectoral policies and circumstances. Then project additionality is proved by means of a barrier analysis, showing that the development of the project activity faces prohibitive barriers, taking into account the impact of CDM registration as a way to overcome these barriers.

The methodology considers emissions from fuel consumption by equipment at the industrial site (boilers, furnaces, cogeneration equipment, etc.), both in the baseline and the project scenarios. These emissions are determined from direct measurements in the project and historical curves (fuel consumption vs. production) in the baseline. The baseline corresponds to the continuation of the current operation modality of the industrial facility.

The methodology also considers emissions from electricity generation outside the industrial site. Electricity purchased from the grid and/or an isolated power plant results in emissions elsewhere in the power grid and/or in the isolated power plant location, and electricity sold from the industrial facility to the interconnected grid reduces such emissions in the power grid. Assuming that the implemented mitigation option (energy integration) contemplates energy savings, increasing electricity self-generation or cogeneration at the industrial site, and/or sale of electricity, emissions from electricity generation outside the industrial facility would decrease as a result of project activity. Thus such emissions are part of baseline emissions and include both *net* electricity purchase prior to project implementation and *net* electricity sale following project implementation (see Section D.6).

These emissions are accounted for through the use of the grid emission factor calculated from the approved consolidated baseline methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable[5] sources."

The case of an isolated power plant must be analysed taking into consideration whether the industrial facility and the other nearby industrial facilities supplied by this isolated power plant are connected to the grid. If the facilities are not connected to the grid, the power plant emission factor must be used to obtain avoided CO_2 emissions. If the facilities are connected to the grid, it is highly probable that they are purchasing electricity from the isolated power plant due to its lower price, so that the reduction of electricity demand from this plant by the industrial facility indirectly has an influence on the purchase of electricity by the other facilities, resulting in emission reductions in the power grid.

The methodology includes specific steps and equations to determine baseline and project emissions in a *quasi*-dynamic manner, from actual measured values following project implementation, by using reference functions (curves obtained from statistical analysis) based on historical data on fuel consumption and electricity purchase/sale vs. production in the baseline scenario (see Section D).

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:

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:

Baseline emissions will be determined in a *quasi*-dynamic way. That is, relationships determined prior to project implementation are used to obtain baseline emissions based on actual production data obtained continuously during the project. Thus, the proposed methodology fits with the first option "Existing actual or historical emissions."

Moreover, the project activity may involve a combination of measures and technologies that are quite project-specific so that no single set of technologies can be used as a package reference, as required in the second baseline approach option. For the same reason, the project is likely to be unique and cannot be readily identified with "similar" project activities elsewhere (the project activity itself is almost independent of the kind of industrial facility and product).

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

[5] Even if this methodology refers to the generation from renewable sources, the final recommendations of the Meth Panel, approved by the CDM Executive Board, to the NM0018 (edited as AM0014) are followed.

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):

The basic assumptions of the baseline methodology are:

- The project activity may involve a series of measures that change energy consumption patterns of the industrial facility. These changes lead to fuel and electricity savings, e.g. by using process heat to generate electricity on-site and/or implementing cogeneration to cover process heat and electricity demand of the industrial facility, etc.
- Baseline fuel usage and electricity purchase/sale can be accurately correlated to production of the industrial facility.
- For calculation of baseline emissions from fuel combustion, a relation between fuel consumption and the production of the industrial facility is established, fixing the value for the fuel consumption that would have been consumed in the baseline scenario for a given value of the production in the project scenario (*quasi*-dynamic baseline).
- The use of combined margin (as outlined in ACM0002) is an appropriate basis to calculate emission reductions from avoided electricity generation.
- For calculation of baseline emissions from outside electricity generation, *net* electricity purchase from the grid or individual power plants prior to project implementation and *net* electricity sale through the grid following project implementation, referred as emissions in the baseline scenario is considered, (see Section D.6).[6] For the estimation of *net* electricity purchase prior to project implementation, a relation between this *net* electricity purchase and the production of the industrial facility is established, fixing the value for the *net* electricity purchase that would have been required prior to project implementation for a given value of the production following project implementation (*quasi*-dynamic baseline).[7]
- The modification of industrial processes does not effect emissions of GHG in other ways.

The equipment involved in the project activity might be only a part of total equipment of the industrial facility. Since all equipment is typically inter-related in a complex and large process, it is consistent to consider total input and output of the facility. On the contrary, if only the equipment involved in the project activity were monitored, there exists the risk that a part of the emissions reduced by the project are emitted anyway due to operation of equipment not controlled following project implementation. Therefore, emission reductions associated with equipment not included in the project activity, as originally proposed in the PDD, can be accredited by project participants, if they are part of minor improvements of some equipment, also helped by CER revenue. Thus, once the project activity has been decided, no energy-intensive equipment would be replaced during the crediting period.

[6] Avoided emissions associated with the sale of electricity following project implementation are considered as baseline emissions instead of discounting them in the project scenario, since they are emissions that would have otherwise been generated in the baseline scenario. (It is similar to what happen with a renewable electricity generation project connected to a grid, since in that case baseline emissions are those avoided by the presence of the project that otherwise would have released —a little fraction of grid emissions— and not the emissions of the entire grid without the project.)

[7] If working directly with the sum of *net* electricity purchase prior to project implementation plus *net* electricity sale following project implementation results to be more convenient than dealing with each term separately and the sum can be directly obtained from monitoring data, then it is not necessary to use the *quasi*-dynamic baseline (see Section D.6).

The baseline corresponds to the continuation of current practice (no energy integration is implemented) at the industrial facility, when the following two conditions are met:

1. There are neither any barriers preventing the continuation of current practice (e.g. regulatory requirements or high maintenance costs as a consequence of obsolescence of equipment) nor any sectoral circumstances driving efficiency measures, and
2. The project is not likely to occur, as there are prohibitive barriers that prevent the implementation of the proposed project activity.

It is assumed that there are no other feasible project activities that provide outputs or services comparable (production of a specific product in an efficient way) with the proposed CDM project activity. While there are different combinations of equipment and operating conditions to achieve energy integration, all of these alternatives are likely to face barriers (typically large investment requirements) similar to the specific energy integration project proposed in a specific PDD. The purpose of the project activity is the reduction of GHG emissions while performing energy savings, regardless of the options for achieving those energy savings. Thus, different energy integration alternatives are a single *type* of project activity. The present methodology is not applicable to project activities where the most likely scenario does not correspond to the continuation of current and historical practice.

Therefore, a two-step analysis shall be performed to demonstrate that the continuation of the current practice is the baseline.

Step 1. The continuation of the current practice is not prevented by barriers or circumstances.

The first condition requires that the continuation of current practice shall be in compliance with all applicable legal and regulatory requirements, even if these laws and regulations have objectives other than GHG reductions, e.g. to mitigate local air pollution. (This analysis does not consider national and local policies that do not have legally-binding status.[8])

If the continuation of current practice does not comply with all applicable legislation and regulations, it must be shown that, based on an examination of current practice in the country or region in which the law or regulation applies, those applicable legal or regulatory requirements are systematically not enforced and that non-compliance with those requirements is widespread in the country.

It must be shown that relevant national and/or sectoral circumstances —such as sectoral reform initiatives, local fuel availability, and the economic situation in the project sector— do not force the company to implement energy efficiency measures at the industrial facility (e.g. in order to be competitive in the market).

This step must also show that there are no barriers that prevent the continuation of current practice, other than regulatory or sectoral policies. Evidence shall be provided to demonstrate that current practice does not involve non-competitive operation and maintenance costs as to obligate project sponsors to change the current mode of operation of the industrial facility.

Step 2. The project activity faces prohibitive barriers that prevent its implementation without CDM registration.

Once demonstrated that the continuation of current practice is a plausible baseline candidate, it must be shown that the proposed project activity is not the baseline, thus proving that the project is additional. Moreover, this also leads to conclude that the continuation of current practice is the baseline.

Additionality shall be assessed through a barrier analysis, as described in Step 3a of the *Tool for the demonstration and assessment of additionality* (Annex 1 to the Report of the 16th meeting of the CDM

[8] This aspect may be modified based on forthcoming guidance from the Executive Board on national and sectoral policies.

Executive Board, Oct. 2004),[9] to determine whether the proposed project activity faces prohibitive barriers that prevent the implementation of this type of proposed project activity, and do not prevent the implementation of the continuation of current practice. In assessing the barriers, factors mitigating barriers such as the existence of programmes for technology support in the host country or subsidies available should be taken into consideration.

The identified barriers are sufficient grounds for demonstration of additionality only if they would prevent potential project proponents from carrying out the proposed project activity if it was not expected to be registered as a CDM activity. This methodology requires that the PDD show how registration of the project under CDM would alleviate the identified barriers and enable the implementation of the project.

In addition, to demonstrate additionality, the barrier analysis shall be complemented taking into consideration the following items:

- If the proposed CDM project activity started before registration, it is necessary to provide evidence that the incentive from the CDM was seriously considered in the decision to proceed with the project activity. This evidence shall be based on (preferably official, legal and/or other corporate) documentation that was available to third parties at, or prior to, the start of the project activity.
- The project activity shall be in compliance with all applicable legal and regulatory requirements.
- An analysis of the extent to which the proposed project type has already diffused in the relevant sector and region shall be performed.

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

The proposed methodology is based on the "Tool for the demonstration and assessment of additionality" and the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002).

The proposed methodology provides a new approach for estimating GHG emissions that would occur in the absence of the project activity. The methodology can be used for energy integration project activities that involve energy efficiency, self-generation, and/or cogeneration.

The impact of the electricity self-generation and cogeneration on an interconnected power system is similar to that from CDM projects involving renewable electricity generation connected to the grid. The calculation tools of the approved consolidated methodology ACM0002 would thus be applicable even though the project does not involve renewable energy. Indeed, this methodology was recommended for use in AM0014, which involves cogeneration of electricity at an industrial facility using a non-renewable fuel.

One of the key features of this baseline methodology is that the total input and output at the industrial facility is considered in order to ensure a thorough accounting of the emissions resulting from the project activity. This feature ensures that emission reductions in one part of the industrial facility that might be counter-balanced by emission increases somewhere else in the facility will be accounted for properly.

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):

[9] Project participants shall use the latest version of the Tool, which should be available on the UNFCCC CDM website.

The methodology proposed here demonstrates that the project activity is additional together with the determination of the baseline scenario (Section D.1). In proving project additionality, Step 3 of the *Tool for the demonstration and assessment of additionality* is used. Furthermore, the methodology requires a demonstration that the project activity faces prohibitive barriers that can be overcome only through CDM registration. Thus the project activity is not a likely baseline scenario. On the other hand, it is demonstrated that the continuation of current practice is the only alternative that does not face any barrier and that is not mandated by regulations or sectoral circumstances. Thus, the continuation of current practice is the baseline and is different from the project activity (which generates lower GHG emissions than the baseline).

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

The type of activity involves equipment and process changes at an industrial facility. Such changes must meet legal requirements, including environmental impact assessment. If the proposed project activity is required by laws or regulations, the project might not be additional. Similarly if there were special incentives to promote project activities similar to the one proposed here, again the activity would not be additional. All these issues are taken into consideration in the baseline determination methodology described in Section D.1. As a part of that determination, the project proponents are required to:

- Analyse legal requirements and obligations with respect to the type of project activity.
- Analyse national incentives to promote similar project activities.
- Analyse sectoral policies that can, directly or indirectly, drive the development of similar project activities.

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

The project boundary encompasses the physical, geographical site of the industrial facility.

Taking into account that a combined margin (as outlined in ACM0002) is considered to calculate emission reductions from avoided electricity generation of power plants connected to the power-grid, the spatial extent of the project boundary includes the project site and also all power plants connected physically to the electricity system that the industrial facility is connected to.

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):

Baseline emissions in a given year, BE (tCO_2e/year), are given by:

$$BE = \Sigma_i \{\Sigma_j BFC_{ij} \times [CEF_j + MEF_j \times GWP(CH_4) + NEF_j \times GWP(N_2O)] + \\ + \Sigma_k (NEPp_{ik} + NESf_{ik}) \times EFel_k\}$$

where the sum over *i* extends to all the days, weeks, or months[10] in a given year, the sum over *j* extends to all the fuels and the sum over *k* extends to all the electricity sources, and:

BFC_{ij}	Consumption of fuel *j* used in the baseline scenario corresponding to the monitoring day, week, or month *i*, expressed in energy units (*e.g.* GJ), and based on lower heating values of fuel *j*
CEF_j	Carbon dioxide emission factor per unit energy of fuel *j* (*e.g.* tCO_2/GJ)
MEF_j	Methane emission factor per unit energy of fuel *j* (*e.g.* tCH_4/GJ)
$GWP\ (CH_4)$	Global warming potential of CH_4 set as 21 tCO_2e/tCH_4 for the 1st commitment period[11]
NEF_j	Nitrous oxide emission factor per unit of energy of fuel *j* (*e.g.* tN_2O/GJ)
$GWP\ (N_2O)$	Global warming potential of N_2O set as 310 tCO_2e/tN_2O for the 1st commitment period
$NEPp_{ik}$	*Net* electricity purchased prior to project implementation corresponding to the monitoring day, week, or month *i*: $NEPp_{ik} = EPp_{ik} – ESp_{ik}$ (electricity purchase less electricity sale) Include *net* electricity purchase from the grid and/or isolated power plants (*e.g.* MWh). Each seller/buyer of electricity is denoted by *k*.
$NESf_{ik}$	*Net* electricity sold following project implementation during the day, week, or month *i*: $NESf_{ik} = ESf_{ik} – EPf_{ik}$ (electricity sale less electricity purchase) Include *net* electricity sale to the grid (*e.g.* MWh). Each buyer/seller of electricity is denoted by *k*.
$EFel_k$	Baseline emission factor from electricity generation, including electricity generation by the grid and/or an isolated power plant (*e.g.* tCO_2/MWh). Each source of electricity is denoted by *k*. This emission factor is calculated using ACM0002.

[10] These days, weeks, or months are those corresponding to the daily, weekly, or monthly monitoring of relevant variables. The daily, weekly, or monthly production values recorded "dynamically" following project implementation in the day, week, or month *i* are the production values used into the "static" baseline curve to determine baseline fuel consumption and *net* electricity purchase. The selection among days, weeks, or months depends on data availability and the size of the sample appropriate to apply a consistent statistical method to construct the static baseline curve that fits the historical data.

[11] IPCC, Second Assessment Report, "1995 IPCC GWP values" adopted by COP3, Decision 2/CP.3, FCCC/CP/1997/7/Add.1. Article 5.3 of the Kyoto Protocol establishes: "The global warming potentials used to calculate the carbon dioxide equivalence of anthropogenic emissions by sources and removals by sinks of greenhouse gases listed in Annex A shall be those accepted by the Intergovernmental Panel on Climate Change and agreed upon by the Conference of the Parties at its third session. Based on the work of, *inter alia*, the Intergovernmental Panel on Climate Change and advice provided by the Subsidiary Body for Scientific and Technological Advice, the Conference of the Parties serving as the meeting of the Parties to this Protocol shall regularly review and, as appropriate, revise the global warming potential of each such greenhouse gas, taking fully into account any relevant decisions by the Conference of the Parties. Any revision to a global warming potential shall apply only to commitments under Article 3 in respect of any commitment period adopted subsequent to that revision." These GWP for methane and nitrous oxide shall be thus adjusted following relevant COP/MOP decisions.

Baseline emissions include emissions from fuels burnt at the industrial facility in the baseline scenario. Baseline emissions also consider emissions from electricity generation outside the industrial site.

Prior to project implementation, electricity purchased to meet a part or all of the demand at the facility would cause emissions elsewhere in the power grid and/or in an isolated power plant. Such emissions should be included as baseline emissions. In the same way, if electricity were sold from the industrial facility through the power grid, there would be emissions offset elsewhere in the grid. Such emissions should be discounted from baseline emissions. Typically, electricity purchase is higher than electricity sale prior to project implementation; in consequence, the subtraction between both types of contributions is considered as *net* electricity purchase, as explained in the definitions of *NEPp*.

If, following project implementation, electricity were purchased, it would cause emissions elsewhere in the power grid and/or in an isolated power plant. If electricity were sold by the industrial facility to the power system, the emissions would be offset elsewhere in the grid. Typically, electricity sale is higher than electricity purchase following project implementation; in consequence, the subtraction between both contributions is considered as *net* electricity sale, as explained in the definitions of *NESf*.

To avoid confusion *NESf* is added in the equation corresponding to baseline emissions instead of discounting it from project emissions (See footnote 6).

Baseline emissions associated with fuel consumption

Ex-ante baseline emissions (i.e. baseline emissions estimated prior to project implementation for the submission of a PDD) related to fuel consumption are determined using values of fuel consumption based on trends in fuel consumption prior to project implementation, for the expected production of the industrial facility following project implementation.

Ex-post baseline emissions (i.e. baseline emissions calculated from monitoring data following project implementation) related to fuel consumption can be determined in a *quasi*-dynamic manner from project monitoring data and relations between fuel consumption in the baseline and production of the industrial facility. The procedure for determining the *quasi*-dynamic baseline is given below.

The *quasi*-dynamic baseline involves the establishment of accurate relations that correlate fuel consumption in the baseline scenario and production of the industrial facility. Preferably, these relations would be uniquely defined (bijective function), meaning that there is a one-to-one correspondence between fuel consumption and production. These relations are based on trends in fuel consumption and production levels under the current practice.

These relations are fixed by using daily, weekly, or monthly data of the three years immediately prior to implementation of the project and will not be altered during the entire crediting period.

More details about the procedure for determining appropriate relations are provided below in "Relations for *quasi*-dynamic baseline calculation."

The *ex-post* baseline fuel consumption will be determined through the relations established from historical data, based on monitored production during the life of the project. In other words, baseline fuel consumption is the quantity of fuel (in energy units) that would have been consumed in the absence of the project activity for the production level measured during project implementation.

This procedure is illustrated in Fig. 1 below.

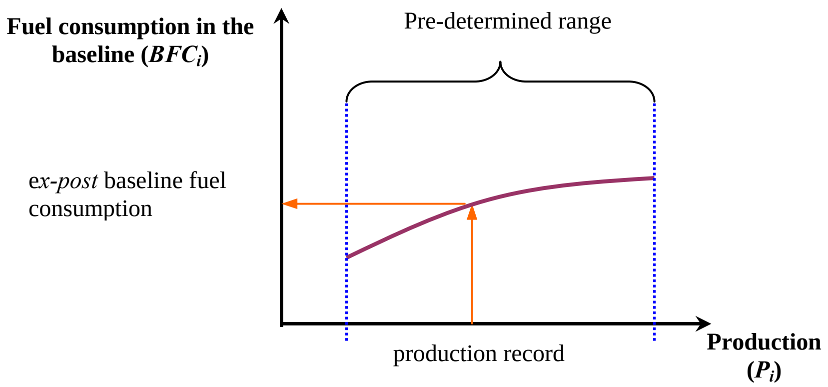

Fig. 1. Determination of fuel consumption in the baseline scenario from historical correlation

In order to calculate daily, weekly or monthly *ex-post* baseline consumption of each fuel *j* (BFC_{ij}), the type and proportion of each one of the fuels consumed in the project are considered to be the same in the baseline scenario.

Thus, *ex-post* consumption of fuel *j* used in the baseline scenario is given by:

$$BFC_{ij} = BFC_i \times \%_{ij}$$

where:

BFC_{ij} Consumption of fuel *j* used in the baseline scenario, corresponding to the monitoring day, week, or month *i*, expressed in energy units (*e.g.* GJ), and based on lower heating value of each fuel. It is considered the same type of fuel as the one consumed in the project.

BFC_i Fuel consumption in the baseline scenario, corresponding to the monitoring day, week, or month *i*, expressed in energy units (*e.g.* GJ), and based on lower heating value of each fuel. It is obtained from the relation established prior to project implementation.

$\%_{ij}$ Proportion of each fuel *j* used in the baseline scenario, corresponding to the monitoring day, week, or month *i*. It is considered the same proportion as the one used in the project. In consequence, it is calculated, based on monitored fuel consumption during the day, week, or month *i*, as follows:

$$\%_{ij} = PFC_{ij} / (\Sigma_j PFC_{ij})$$

where PFC_{ij} is the consumption of fuel *j* used in the project scenario corresponding to the monitoring day, week, or month *i*, expressed in energy units (*e.g.* GJ), and based on lower heating values of each fuel.

This methodology considers that, in the baseline scenario, the same kind and proportion of fuels that are consumed following project implementation would be consumed. In consequence, fuel switching is not covered by the current methodology.

Baseline emissions associated with purchase/sale of electricity

The emissions associated with electricity generation outside the industrial facility depend on the sum of the *net* electricity purchase prior to project implementation and the *net* electricity sale following project implementation, and the emission factor for electricity generation.

Net electricity purchase prior to project implementation

Ex-ante baseline emissions related to *net* electricity purchase are determined using values of electricity purchase and sale based on trends in electricity purchase and sale prior to project implementation, for the expected production of the industrial facility following project implementation.

Ex-post baseline emissions related to *net* electricity purchase can be determined in a *quasi*-dynamic manner from project monitoring data and relations between electricity purchase/sale in the baseline and production of the industrial facility. Preferably, these relations would be uniquely defined (bijective function), meaning that there is a one-to-one correspondence between electricity purchase/sale and production. These relations are based on trends in electricity purchase and sale and production levels under the current practice.

These relations are fixed by using daily, weekly, or monthly data of the three years immediately prior to implementation of the project and will not be altered during the entire crediting period.

More details about the procedure for determining appropriate relations are provided below in "Relations for *quasi*-dynamic baseline calculation."

The *ex-post* baseline electricity purchase and sale will be determined through the relations established from historical data, based on monitored production during the life of the project. In other words, baseline electricity purchase and sale is the quantity of electricity that would have been purchased and/or sold in the absence of the project activity for the production level measured during project implementation. The procedure is the same that is described above for estimation of *ex-post* baseline emissions related to fuel consumption. A graph similar to the one shown in Figure 1 will be used to correlate electricity purchase/sale to production.

Net electricity sale following project implementation

Ex-ante baseline emissions related to *net* electricity sale following project implementation are determined using values of electricity purchase/sale based on estimates of the technological changes introduced by the project activity. *Ex-post* baseline emissions related to *net* electricity sale following project implementation will be determined from project monitoring data.

As mentioned above, if working directly with the sum of *net* electricity purchase prior to project implementation plus *net* electricity sale following project implementation results to be more convenient than dealing with each term separately and the sum can be directly obtained from monitoring data, then it is not necessary to use the *quasi*-dynamic baseline.

This happens, for example, when the current practice does not involve electricity generation, which is added by the project activity. In that case, avoided power-grid CO_2 emissions are directly obtained as the amount of electricity generated by the new generation equipment, since the difference between electricity purchase in the baseline and project scenario plus the electricity sale in the project (if any) is the quantity of electricity generated by the new turbo-generator in the project (EG_i). It means:

$$NEPp_i + NESf_i = (EPp_i - ESp_i) + (ESf_i - EPf_i) = (EPp_i - EPf_i) + ESf_i = EG_i$$

Emission factor for electricity generation outside the industrial facility

If the project activity involves purchase/sale of electricity from/to the grid, the Methodology Panel and CDM Executive Board have already proposed a consolidated methodology for determining the emission factor. This approved consolidated baseline methodology, identified as ACM0002, is adopted as an appropriate basis to calculate emission reductions from avoided electricity generation. ACM0002 offers some alternative pathways for determining the emission factor, and each specific PDD should adopt a specific procedure, according to its circumstances and criteria stated in ACM0002.

ACM0002 deals with grid-connected electricity generation from renewable sources. When the project activity involves electricity generation from renewable sources, project emissions for electricity generation are mostly negligible, and the baseline emissions are emissions avoided elsewhere in the power grid. The new methodology proposed here is related to electricity generation at an industrial facility using fuels, which are not necessarily renewable. However, emissions released from burning these fuels are counted as part of project emissions due to fuel consumption at the facility. Therefore, ACM0002 is appropriate for calculating avoided emissions related to electricity generation in this methodology. Indeed, another approved methodology, "Natural gas-based package cogeneration," was accepted as AM0014 under the condition that ACM0002 be used.

AM0014 offers an alternative procedure for estimating the emission factor, namely the "Simplified Methodology for Small-scale CDM Project Activities," which would be applicable in case electricity displaced is less than or equal to 15 MW equivalent.

Thus, following the criterion proposed in AM0014, when the project activity involves purchase/sale of electricity from/to the grid, this proposed new methodology recommends the use of either ACM0002 or the simplified methodology for small-scale projects, if electricity displaced is less than or equal to 15 MW equivalent.

On the other hand, if the proposed project activity involves purchase/sale of electricity from an isolated power plant, it is necessary to consider whether the industrial facility and the other nearby industrial facilities supplied by this isolated power plant are connected to the grid. If the facilities are not connected to the grid, the power plant emission factor must be used to obtain avoided CO_2 emissions. If the facilities are connected to the grid, it is highly probable that they are purchasing electricity from the isolated power plant due to its lower price, so that the reduction of electricity demand from this plant by the industrial facility indirectly has an influence on the purchase of electricity by the other facilities, resulting in emission reductions in the power grid.

Relations for *quasi*-dynamic baseline calculation

The relations used to determine ex-post baseline emissions are developed through a statistical method described in Section F. The method requires determining the curve that best fits a set of pairs of values. This methodology proposes collecting daily, weekly or monthly data (according to data availability) corresponding to the last three years of operation of the industrial facility.

The relations shall cover the range of total production values of the industrial facility that is expected during the crediting period based on historical data. However, if the range is exceeded during the project, this methodology allows the extrapolation of the curves obtained *ex-ante* without exceeding the maximum production capacity of the existing facility. Extrapolation is valid because the relations are based on a great amount of data that represent different operation conditions and production levels. Thus the statistic method allows one to determine and extrapolate representative curves.

If there were equipment that produces electricity from burning fuels in the baseline, a basic hypothesis of this methodology (fuel and electricity are not causally related) would not be met. In that case, this methodology could even be applied if this equipment is not changed by the project activity and it is

possible to guarantee that its operation is not modified by the project activity. Moreover, in order to decide what are fuel consumption and electricity purchase/sale that would have occurred in the absence of the project activity, the operation mode of this equipment must be clearly identified. A concrete case of this behavior corresponds to a turbo-steam generator that can be used in a day depending on the comparison between fuel and electricity prices. In that case there are two possibilities: to use or not this equipment on that day. Therefore, two different curves shall be obtained for the relation between fuel consumption and production level and other two curves for the relation between electricity purchase and production level. For a given production the higher the fuel consumption is the lower electricity purchased will be, and vice-versa.

To account for baseline emissions in this eventual case the following procedure shall be executed:

i) Monitor daily[12], following project implementation, the use of the turbo-steam generator.

ii) Intersect the curve that corresponds to the mode of operation applied on that day (on/off) following project implementation, as much as for fuel consumption vs. production as electricity purchase vs. production.

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 project activity may include fuel and electricity savings, increased electricity generation at the facility, and sale of energy. Either of these components would reduce GHG emissions compared to the baseline.

The project emissions E (tCO_2e/year) are given by:

$$E = \Sigma_i \{\Sigma_j PFC_{ij} \times [CEF_j + MEF_j \times GWP(CH_4) + NEF_j \times GWP(N_2O)]\}$$

where:

PFC_{ij}	Consumption of fuel *j* used in the project scenario corresponding to the monitoring day, week, or month *i*, expressed in energy units (*e.g.* GJ), and based on lower heating values of each fuel
CEF_j	Carbon dioxide emission factor per unit energy of combusted fuel *j* (*e.g.* tCO_2e/GJ)
MEF_j	Methane emission factor per unit energy of combusted fuel *j* (*e.g.* tCH_4/GJ)
$GWP(CH_4)$	Global warming potential of CH_4 set as 21 tCO_2e/tCH_4 for the 1st commitment period
NEF_j	Nitrous oxide emission factor per unit energy of combusted fuel *j* (*e.g.* tN_2O/GJ)
$GWP(N_2O)$	Global warming potential of N_2O set as 310 tCO_2e/tN_2O for the 1st commitment period

Project emissions correspond to emissions from fuels burnt at the industrial facility. If electricity were exported from the facility, this would offset emissions from energy generation outside the industrial facility. Such emissions were already counted in baseline emissions, as well as emissions associated with *net* electricity purchase prior to project implementation. Additional details on emissions associated with

[12] Under this case, a daily monitoring is required by this methodology. Exceptions shall be transparently justified.

electricity generation outside the project facility, including the methodology to be used in order to estimate such emissions, were presented in Section D.6.

Ex-ante project emissions (i.e. project emissions estimated for the submission of a PDD) are determined using values of fuel consumption based on estimations from studies and/or simulations for the project scenario, and *ex-post* project emissions can be determined from monitoring data of the project.

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

The methodology addresses leakage from upstream fuel production and delivery. Emissions from fuel production, pipeline and distribution, and CO_2 emissions from fuel transportation are considered as leakage. Emissions from fuel production/transportation are counted only if the fuel is produced/transported in a non-Annex I country.

Typical fuels might be natural gas, diesel, heavy fuel oil, bunker fuel, coal, etc. Fugitive methane emissions are associated with natural gas production and pipeline leakage. Fugitive methane emissions are also associated with coal mining. In case that the effect of these methane emissions could not be neglected, it should be included here.

The leakage LE is given by:

$$LE = \Sigma_i \{\Sigma_j (PFC_{ij} - BFC_{ij}) \times FE_j (CH_4) \times GWP (CH_4) + \Sigma_j PTF_{ij} \times EF_j - \Sigma_j BTF_{ij} \times EF_j\}$$

where $FE_j (CH_4)$ is the IPCC default methane emission factor of fuel j associated with fugitive emissions.

The second and third terms within the first summatory in the above formulae refer to emissions from fuel transportation in the project and baseline scenarios, respectively, shown as a product of the energy content of the fuels consumed in transporting fuels to the facility and the corresponding CO_2 emission factor for the fuels consumed by the different transportation modes (such as marine, railroad or truck). In view of the relatively small magnitude of CO_2 emissions from fuel transportation to typical industrial facilities, IPCC emission factors can be used.

The quantity of fuels consumed in transporting fuels to the facility (PTE_{ij} or BTE_{ij} in energy units, and based on lower heating value of each fuel) can be obtained in a facility-specific way. It can be calculated as the product of the specific energy consumption of the transport mode (quantity of fuel consumed per unit of fuel transported in the round trip,) and the quantity of fuel transported (fuel consumed at the industrial facility corresponding to the monitoring day, week, or month i).

The quantity of fuel consumed is expressed in energy units and based on its lower heating value. The quantity of fuel transported is expressed in units of mass or volume.

The specific energy consumption of the transport mode is determined *ex-ante* from historical data or estimations, and it is considered fixed during the crediting period. This simplification is valid because of the relatively small magnitude of CO_2 emissions from fuel transportation to typical industrial facilities.

Thus to estimate the leakage before and after project implementation it is necessary to determine *ex-ante* and *ex-post* consumption of fuel j at the industrial facility used in the baseline and project scenarios, which can be determined as explained in Sections D.6 and D.7, respectively.

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 emission reductions *ER* (tCO_2e/year) generated by the project activity are given by:

$$ER = BE - E - LE$$

Total emission reductions should be estimated *ex-ant*e and determined *ex-post* as explained in Sections D.6, D.7, and D.8 above. The *ex-ante* estimation of total emission reductions shall be reported in the PDD submitted for validation.

SECTION E. Data sources and assumptions:

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

The parameters are listed together with data sources in Section E.3, below.

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:

Calculation depends on the values of the following parameters, whose sources are given below:

Table 1: parameters

Symbol	Definition	Data source (in order or preference) and justification
CEF_j	Carbon dioxide emission factor per unit energy of fuel *j* (*e.g.* tCO_2/GJ)	1. National inventory of GHG emissions, prepared as part of the National Communications to the UNFCCC or other official documents. This is the most important emission factor and thus needs to be based on the most reliable and specific data source as possible. 2. On-site measurements of carbon content and calorific value of fuels. This would be recommended for fuels where there is significant variation in properties and/or when the fuel is not widely commercialised. 3. IPCC default emission factors. This is the last choice, and should be used only where data from other sources are not available.
MEF_j	Methane emission factor per unit energy of fuel *j* (*e.g.* tCH_4/GJ)	IPCC default values. Methane emissions from fuel combustion are likely to be insignificant so that standard values should suffice to provide an adequate estimate.
NEF_j	Nitrous oxide emission factor per unit of energy of fuel *j* (*e.g.* tN_2O/GJ)	IPCC default values. Nitrous oxide emissions from fuel combustion are likely to be insignificant so that standard values should suffice to provide an adequate estimate.
$EFel_j$	Baseline emission factor from energy generation, including electricity generation by the grid and/or a private plant (*e.g.* tCO_2/MWh). Each energy source is denoted by *j*.	If the project activity involves purchase/sale of electricity from/to the grid, emission factor is determined using either: ▪ ACM0002 "Consolidated methodology for grid-connected renewable electricity generation from renewable sources." ▪ Simplified methodology for small-scale CDM project activities (for electricity generation less than or equal to 15 MW equivalent). If the project activity involves purchase of electricity from isolated power plants, the emission factors provided by power plant owners shall be used, unless the electricity is displaced indirectly from the grid (see Section B).

Emissions from grid-connected electricity generation require data that are specified in ACM0002, and depend on the specific methodological option chosen among several alternatives proposed therein.

Leakage calculations are likely to be small compared to other components of baseline and project emissions; so that IPCC default values may be chosen for these estimates.

As mentioned above, the *quasi*-dynamic baseline calculation involves the establishment of adequate relations between production and fuel consumption and/or electricity purchase/sale in the baseline scenario. These relations will be established prior to project implementation and considered unalterable during the crediting period. As a consequence, any estimation that is used to establish the relations needs an appropriate justification.

Following project implementation, *ex-post* baseline fuel consumption and electricity purchase and sale will be determined through the relations established prior to project implementation, based on records of production in the monitoring process. As a consequence, it is assumed that the daily, weekly, or monthly production level of the industrial facility is the same in both, the baseline and project scenarios.

When electricity purchase/sale remains approximately constant prior to project implementation, and it is also estimated that they would be constant in the absence of the project activity, this methodology includes the possibility of considering them as fixed values for the baseline scenario.

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

When historical values of fuel consumption and electricity purchase/sale are used to determine baseline emissions, a period of at least three years is required prior to project implementation.

Specifically, when historical values of fuel consumption, electricity purchase/sale, and production level of the industrial facility are used to determine the relations for the *quasi*-dynamic *ex-post* baseline calculation, daily, weekly, or monthly data are required for at least three years prior to project implementation, in order to obtain enough data to have good statistical results.

This three-year data vintage is adequate when the data are available; the data lead to a statistically valid regression analysis; and the data can accurately cover a range of operating scenarios that are reasonably expected to occur during the project crediting period.

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

Fuel consumption, electricity purchase/sale, and production data correspond to the industrial facility. The spatial level of these data is local.

Emissions from grid-connected electricity generation require data that are specified in ACM0002, and depend on the specific methodological option chosen among several alternatives proposed therein. Parameters needed to determine the emission factor for grid-connected electricity generation depend on the wholesale electricity manager and power plants connected to the grid in question. The spatial level of these data is regional or national (the project electricity system is defined by the spatial extent of the power plants that can be dispatched without significant transmission constraints).

If the project activity involves purchase of electricity from isolated power plants, local emission factors corresponding to those plants should be used, unless the electricity is displaced indirectly from the grid.

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

To estimate baseline emissions, relations based on fuel consumption, energy purchase/sale, and production data recorded prior to project implementation shall be determined using statistical analysis. A function shall be determined allowing one to calculate the ordinate for a given value of the abscissa. If a large number of cases is collected (for example, daily values during the last three years), the historical series is likely to be sufficiently dense to yield a function that is an accurate approximation of what would have occurred in the absence of the project activity. The calculated baseline emissions on any given day may differ from what would have actually occurred. However, the statistical analysis shall ensure that, on average, the calculated baseline emissions are valid.

Following project implementation, daily, weekly, or monthly fuel consumption, electricity purchase/sale, and production will be accurately recorded, according to measurement procedures established in the monitoring plan.

This methodology assumes that the daily, weekly, or monthly production level of the industrial facility is the same in both, the baseline and project scenarios. Thus *ex-post* baseline fuel consumption and electricity purchase and sale will be determined through the relations established prior to project implementation, based on measurements of the production in the monitoring process.

The methodology also assumes that, in the baseline scenario the same type and proportion of fuels are consumed as in the project.

GHG emissions are dominated by CO_2 emissions from fuel combustion and electricity generation outside the industrial facility. Variations due to changes in the industrial process are smoothed since the established relations are determined from a robust set of values representing several operational conditions.

CO_2 emissions from fuel combustion are determined from emission factors and lower heating values of each fuel, which are known with a high level of accuracy. There are large uncertainties in the emission factors of methane and nitrous oxide in combustion. Project or country specific values are unlikely to be available, and even IPCC sources show gaps in estimates. However, in terms of CO_2 equivalent, the emissions of methane and nitrous oxide in combustion make up a very small part of total GHG emissions, so that these uncertainties are not important.

For emissions associated with grid-connected power generation, the methodology proposed here for dealing with these emissions is the approved consolidated methodology ACM0002. ACM0002 includes multiple options for determining the emission factor for grid-connected electricity. The result is likely to be sensitive to the option chosen, but the chosen option will be subject to review by a DOE and others for appropriateness.

Leakage calculations are likely to be small compared to other components of baseline and project emissions and country specific values are unlikely to be available, so that these uncertainties are not important and IPCC default values may be chosen for these estimates. However, in the calculation of emissions from fuel transportation, the specific energy consumption of the transportation mode is determined prior to project implementation from historical data or estimations, and it is considered fixed during the crediting period. This simplification is valid since the relatively small magnitude of CO_2 emissions from fuel transportation to typical industrial facilities.

Curve fitting model in the analysis of straight-line data

The model is based on a polynomial estimation using multiple linear regression.

The idea of the method is to provide a polynomial adjustement to a sample of points resulting from two random variables, not up to the extent of joining every single point, but preserving a statistical value that could be borrowed from and used in other samples of the same two variables under the same experimental conditions.

Polynomial estimation using multiple linear regression

Consider two random variables, X and Y, correlated, with a bivariate normal distribution (that is, for every x there is a set of values of Y normally distributed, and for every y, there is a set of values of X normally distributed). For every $X=x$, $E(Y/X=x)$ —conditional expectation of Y to x— is estimated from a sample of pairs $\{(x_i, y_i), i=1,...,n\}$ measured on the same experimental sample.

A linear regression model with polynomial estimation is proposed:

$$E(Y/X=x) = \alpha_0 + \alpha_1 x + \alpha_2 x^2 + ... + \alpha_p x^p$$

where p is a natural number such that $p \leq n$, for some coefficients $\alpha_0, \alpha_1, ..., \alpha_p$ and for every x in an interval of values $(min\ \{x_i\}, max\ \{x_i\})$. With this expression, a specific estimation of $E(Y/X=x)$ is made, using the values $\hat{\alpha}_0, \hat{\alpha}_1, ..., \hat{\alpha}_p$, which are obtained by means of the multiple linear regression method (the method is linear in the coefficients $\hat{\alpha}_0, ..., \hat{\alpha}_p$).

A fitting curve for $E(Y/X=x)$ (within a reasonable model, explained below) is seeked for, with a polynomial of the smallest possible degree, since if

$$Y = \alpha_0 + \alpha_1 X + ... + \alpha_{p_0} X^{p_0} + \varepsilon, \quad E(\varepsilon) = 0$$

to propose

$$Y = \alpha_0 + \alpha_1 X + ... + \alpha_p X^p + \varepsilon', \quad \text{with } p > p_0$$

reduces the influence of variable ε' on the randomness of variable *Y*, and that is not adequate because it would be overestimating the representative curve.

Besides, it is not recommended to propose polynomials of degree higher than *p*=5, because the terms are correlated, since they are powers of the same variable *X* (multicolinearity). And, due to what has been previously said, for very large *p*, the polynomial would strongly depend on the sample (data pairs) used.

For the selection of the adequate polynomial, project participants shall proceed with the following algorithm:

1) Calculate the following linear regression polynomial

$$y = \hat{\alpha}_0' + \hat{\alpha}_1' x + \cdots + \hat{\alpha}_k' x^k$$

and the polynomial

$$y = \hat{\alpha}_0' + \hat{\alpha}_1' x + \cdots + \hat{\alpha}_{k+1}' x^{k+1}$$

starting at *k*=1 onwards.

2) Run a test to decide if it is necessary to include the term of degree *k*+1 in the analysis. Therefore consider the following:

$$\mathrm{SCE}_1 = \sum_{i=1}^{n} \left(y_i - \left(\hat{\alpha}_0 + \hat{\alpha}_1 x_i + \cdots + \hat{\alpha}_k x_i^k\right)\right)^2$$

$$\mathrm{SCE}_2 = \sum_{i=1}^{n} \left(y_i - \left(\hat{\alpha}_0' + \hat{\alpha}_1' x_i + \cdots + \hat{\alpha}_{k+1}' x_i^{k+1}\right)\right)^2$$

and

$$F = \frac{(SCE_1 - SCE_2)/1}{SCE_2 / (n - (k+1))}$$

Assume the hypotheses

$$H_0: \quad \alpha_{k+1} = 0 \qquad\qquad H_a: \quad \alpha_{k+1} \neq 0$$

and the decision rule will be to reject H_0 if the "*p*-value" (significance level[13]) is lower than 0.05, using the statistic *F*.[14]

If H_0 is not rejected, use the polynomial of degree *k* to estimate $E(Y/X=x)$. If H_0 is rejected, repeat point (2) increasing *k* in one unit.

3) If the method leads to use a polynomial with $k>5$, discard the procedure on the basis of what has been explained on the degree of the polynomial.

4) In case we have obtained $E(Y/S=x)=\hat{\alpha}_0+\hat{\alpha}_1 x+\ldots+\hat{\alpha}_k x^k$ as the polynomial that adjusts the measured points (with $k\leq 5$), calculate Pearson's correlation coefficient *R* for multilinear regression, in order to quantify the degree or percentage of correlation between the two variables, *X* and *Y*, explained by the model.

$$R^2 = 1 - \frac{SC_E}{Syy}$$

It is recommended that R^2 be greater than R^2_0, value which is estimated through a test of the correlation coefficient

$$\rho = \frac{Cov(X,Y)}{\sqrt{Var(x)}\sqrt{Var(y)}}$$

with hypotheses H_0: $\rho=0.50$, H_a: $\rho>0.50$, with significance level $\alpha = 0.05$. Because the sample is large, apply the statistic

$$Z = \frac{\frac{1}{2}\ln\left(\frac{1+R}{1-R}\right) - \frac{1}{2}\ln\left(\frac{1+0.5}{1-0.5}\right)}{\frac{1}{\sqrt{n-(k+2)}}}$$

which, in the event H_0 be true, has a distribution approximately N(0;1). R^2_0 is the smallest value of R^2 that leads to reject H_0. Thus, it is guaranteed, with that significance level, that the variability percentage of *Y* explained will be higher than 25%.[15]

If R^2 turns out to be lower than R^2_0, a conservative proposal is made estimating *Y*-values by the ones calculated by the polynomial of degree *k*, minus the estimation of the standard deviation of *Y*, that is:

$$\tilde{Y} = \hat{\alpha}_0 + \hat{\alpha}_1 x + \ldots + \hat{\alpha}_k x^k - \hat{\sigma} = \hat{Y} - \hat{\sigma}$$

---

[13] The probability of an observed result happening by chance under the null hypothesis.

[14] *F* has Fisher distribution with one degree of freedom in the numerator and $n-(k+1)$ in the denominator; H_0 is rejected at α-level if $F>F_{\alpha;\,1;\,n-(k+1)}$.

[15] It is based on the fact that if $R>0.80$ the variables are considered strongly correlated. For $0.50<R<0.80$ the variables are moderately correlated, and for $R<0.50$ the variables are weakly correlated. Therefore, it is stated that only if the variables are weakly correlated the conservative assumption shall be used.

where

$$\hat{\sigma} = S = \sqrt{\frac{SCE}{n-(k+1)}}$$

with

$$SCE = \sum (y_i - (\hat{\alpha}_0 + \hat{\alpha}_1 x_i + ... + \hat{\alpha}_k x_i^{\ k})^2$$

In this way, the values of *Y* are conservatively underestimated, since *Y* is the fuel consumed or net electricity purchased in the baseline. To make this choice is equivalent to demand that the values of *Y* should be smaller than the values of the confidence interval for *E*(*Y/X*=*x*):

$$Y = \hat{Y} \pm t_{\frac{\alpha}{2}}; n-(k+1) \cdot S \sqrt{1 + \frac{(x-\bar{x})^2}{S_{xx}}}$$

with $\alpha \cong 0.30$, that is a 15% probability that *E*(*Y/X*=*x*) > $\tilde{Y}$ is not met, within the $n \geq 30$ approximation.

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

All equations that make up the determination of baseline emissions are straightforward and transparent.

In the establishment of the relations between production and fuel consumption and electricity purchase/sale based on historical data of the industrial facility, a large number of cases should be collected in order to obtain historical series sufficiently dense to ensure the function obtained is an accurate approximation of what would have been occurred in the absence of the project activity.

The statistical method presented in this methodology is a conservative approach for fitting historical values with representative curves.