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Working Paper

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Lessons from the submission and approval process of energy-efficiency CDM baseline and monitoring methodologies

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Abstract: Energy efficiency is a CDM project type that suffers from high methodology rejection rates. 43 baseline and monitoring methodologies for CDM energy efficiency projects are analyzed with respect to reasons for approval / rejection by the CDM Executive Board. Most methodologies have been rejected because they did not comply with implicit quality standards regarding presentation and conservativeness. Also, tools to select the baseline scenario and to prove additionality were frequently lacking. If the level or the quality of production in the baseline or the project scenario changes, a simple before-after-comparison is not valid. Black box models are not accepted and methodologies should be sufficiently differentiated to account for specific (technical) circumstances. The remaining lifetime of equipment has to be taken into account. Often, elements of small-scale methodologies have been retained in approvals of large-scale methodologies.

Introduction

The Marrakech Accords (2001) do not provide a definition of detailed methodological proceedings for setting baselines and monitoring emission reductions from CDM project activities, because the Parties opted for a bottom-up approach. Except for small-scale project activities, baseline and monitoring methodologies have to be developed by the project proponents. The proposals are submitted to the Executive Board (EB) with assistance from a panel of methodology experts (Meth Panel)[1] which decides upon approval (rating A) and rejection (rating C). Apart from that, the EB can maintain a methodology in process (rating B), when a methodology has a certain potential for approval but would require major changes by the project participants. The methodology is sent back to the project participants with required changes indicated. The project participants are then free to resubmit their improved methodology. This feed-back loop has been introduced in order to enhance the chances for approval.

Nevertheless, the approval rate of energy efficiency methodologies is low. Out of 43 submitted proposals, only 7 have been approved so far. Due to consolidations, there are now 4 approved methodologies (AM0014, AM0017, AM0018 and AM0020) and 2 consolidated methodologies (ACM0003 and ACM0004) available for energy efficiency measures.

This discussion paper aims at revealing reasons for rejection of energy efficiency methodologies and deducing recommendations for the design of new proposals.

The first chapter draws lessons from the methodological settings of small-scale methodologies, which are the only ones defined top-down. The second chapter then analyses the submissions of large-scale methodologies to the Executive Board based on the recommendations made by the Meth Panel. The following chapter describes the design of the approved methodologies, which provides inside into the level of methodological standards required by the Executive Board. The last chapter summarises the lessons learned from the submitted proposals and the approved large-scale methodologies. In addition, first conclusions regarding the lessons drawn from small-scale methodologies are provided.

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[1] Normally, the EB decision follows the suggestion from the Meth Panel.

1. Lessons from the "top-down" definition of baseline methodologies in the context of SSC CDM projects

Negotiators at the Marrakech Conference realised that small CDM projects suffer from high transaction costs that make them unviable at current CER prices (for a quantitative assessment of transaction costs see Michaelowa et al. (2003)). As a consequence, they decided CDM rules should contain an element that renewable energy projects below 15 MW installed capacity, energy savings projects with less than 15 GWh annual savings or other project types with less than 15,000 t annual CO_2 eq. emissions would benefit from simplified rules. Thus, energy efficiency projects were recognized as a major category.

This decision paved the way for the only "top-down" definition of baseline methodologies done in the context of the international CDM rules[2]. Based on the work of the Small-Scale Panel, the CDM Executive Board specified 15 project categories with distinct baseline rules, of which six address energy efficiency improvements (UNFCCC 2005). These project categories are as follows:

1. Supply side energy efficiency improvements for transmission and distribution
2. Supply side energy efficiency improvements - generation
3. Demand-side programmes for specific technologies;
4. Energy efficiency and fuel switching measures for industrial facilities
5. Energy efficiency and fuel switching measures for buildings
6. Energy efficiency and fuel switching measures for agricultural facilities and activities

Soon it became apparent that small-scale baseline rules influenced rule-setting for large projects. For example, the concept of operating and build margin for projects related to electricity that became the principle of large-scale electricity baseline methodologies was first specified in the rules for small-scale renewable electricity generation for a grid. This paper thus assesses the rules for the five types of energy efficiency projects and draws lessons for large-scale methodologies. First, general principles found in all project types are discussed before going into the specifics.

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[2] In the meantime, several consolidated baseline methodologies have been developed by the CDM EB, however always based on previously accepted large-scale methodology submissions.

1.1 Deriving an energy and an emissions baseline

The methodologies all start from deriving an energy use baseline. The baseline energy consumption then applies a greenhouse gas emissions factor to define the emissions baseline. This two-step procedure is likely to be retained for large-scale energy efficiency methodologies. Emission factors for electricity-related projects are likely to be calculated on the basis of approved baseline methodologies for the electricity sector such as the consolidated methodology for renewable electricity projects for a grid (ACM 2). Emission factors for fossil fuels are generally taken from the IPCC good practice database for default emission factors, but direct testing of fuel samples is required in the case of projects improving energy efficiency of generation using coal. It is thus likely that emissions factors derived from sampling will be used for fuels with a high emissions factor variability for large-scale methodologies.

1.2 Differentiation between retrofit and new equipment

All five methodologies make a clear distinction between retrofitting existing equipment and installing new one. For retrofit in the case of transmission and distribution, the energy baseline is the measured performance of the existing equipment, essentially using approach a) of the Marrakech Accords. Alternatively, an equipment standard (see 4. below) can be used. Retrofits increasing efficiency of renewable power plants are treated as renewable electricity generation projects generating the amount of electricity that is gained by the efficiency increase. For upscaling, this would mean that those projects could use the consolidated methodology for renewable electricity projects for a grid (ACM 2). In the context of retrofits, it is not discussed at all for which time the replaced equipment would have continued operation.

The energy baseline of new equipment is the equipment that would have been installed otherwise. However, the rules do not define how to determine the "business-as-usual" type of new installation, i.e. which general baseline approach of the Marrakech Accords to take and thus leave a gap at the centre of baseline determination. Here, a control group approach could be chosen to operationalize approach c). Or it could be calculated which new equipment would be economically most attractive (approach b), taking into account equipment standards (see 4. below).

1.3   Equipment standards

For new equipment, business-as-usual definition is to take into account efficiency standards, if they exist. A tiered approach like in the context of IPCC guidelines is applied. The first tier/choice is a national standard, if existing. The second tier is an International Organization for Standardization (ISO) / International Electrotechnical Commission (IEC) standard, while the last tier would be the manufacturer's specifications. For new installations under the project category "Demand-side programmes for specific technologies", the weighted power average of the equipment on the market is used to calculate the energy baseline. Manufacturer's data are used to define the power of each piece of equipment.

1.4   Use of samples

For the project category "Demand-side programmes for specific technologies", "appropriate" samples can be used for both options to derive the energy baseline: metering the power and operating hours of the equipment or metering the energy use. The rules however do not state in detail how the sample size is to be determined; they only say that for fixed loads the sample can be small while for variable loads it has to be large. Another sample shall be used to check the share of equipment which is still operational.

1.5   Monitoring: measuring or estimating emission factors

The project type "Supply side energy efficiency improvements for transmission and distribution" requires measurement of technical energy losses or test results from commissioning of the new equipment, while other project categories reducing electricity consumption can also use published values. The amount of fossil fuel used has to be monitored in any case.

For "Demand-side programmes for specific technologies", monitoring addresses both the power of each equipment and operation time. These two parameters shall be metered while a sample can be used.

The project type "Energy efficiency and fuel switching measures for industrial facilities" requires metering of energy use of the whole facility. Thus here sampling or estimating is not possible.

For agricultural projects, the number of ha cultivated and the crop yield has to be monitored in order to ensure that reduced energy consumption is not due to downscaling of activities.

1.6   Conclusions for large scale methodologies

Small-scale methodologies cover all conceivable types of energy efficiency improvement projects, differentiated in six categories. The main elements that can be found throughout these methodologies are a differentiation between retrofits and new equipment. The key question of "equipment that would have been installed otherwise" has however been left open. Monitoring allows sampling but the character of the samples has not been defined. Astonishingly, the concepts of "control group" or the "remaining lifetime of equipment" have not been used.

So far, only three small-scale energy efficiency projects have been submitted for comments in the CDM validation pipeline, one of which addresses industrial energy efficiency. None of these projects has been registered so far. So we do not have any experience with the actual use of the small-scale methodologies.

2. Evaluation of large-scale energy efficiency methodology proposals submitted to the EB

2.1 Overview of the energy efficiency methodologies submitted to the Executive Board

As of June 2005, the following 43 methodologies had been submitted for energy efficiency project activities:

Methodology	Status	Type[1]
NM0003: Construction of new methanol production plant (called: M 5000)	C	4
NM0017-rev: SGS - Steam system efficiency improvements in refineries in Fushun, China	A	4
NM0018-rev: Metrogas Package Cogeneration Project	A	2
NM0031-rev: OSIL 10 MW Waste Heat Recovery Based Captive Power Project	A; in ACM	4
NM0033: Holcim Costa Rica: Cartago Plant Expansion Project	B	4
NM0037-rev: Energy efficiency through installation of modified CO_2 removal system in Ammonia Plant	A	4
NM0040: Replacement of Fossil Fuel by Palm Kernel Shell Biomass in the production of Portland Cement	A	4
NM0042rev: Energy efficiency improvements in municipal water utilities in Karnataka, India - water pumping efficiency improvement	A	4
NM0044: Energy Efficiency Improvements in Municipal Water Utilities in Karnataka, India - power factor improvements	C	4
NM0045-rev2: Birla Corporation Limited: CDM project for "Optimal Utilization of Clinker"	in process	4
NM0046: Andijan District Heating Project	C	1
NM0047-rev: Indocement Sustainable Cement Production Project - Blended Cement Component	In process	4
NM0049: Waste heat recovery from BOF Gas at Jindal Vijayanagar Steel Limited through Power generation and supply to Karnataka Grid as also Jindal Vijayanagar Steel Limited ("JVSL") in Karnataka, India	C	4
NM0052: Urban Mass Transportation System (TransMilenio), Bogotá DC, Colombia	C	NA
NM0058: Energy Efficiency Improvements-Hou Ma District Heating, Shanxi Province, China	C	1
NM0059: Optimization and Co-Generation of Energy from Steel Making Process -	C	4

energy co-generation from steel making gas recovery		
NM0064: Optimization and Co-Generation of Energy from Steel Making Process - electric energy consumption reduction in steel making process	C	4
NM0070: Conversion of existing open cycle gas turbine to combined cycle operation at Guaracachi power station, Santa Cruz, Bolivia	In process	2
NM0071-rev: BOF Gas recovery at Jindal Vijayanagar Steel Limited (JVSL) and combustion for power generation and supply to Karnataka Grid, India.	C	4
NM0072: Mandatory Energy-Efficiency Standard for Room Air Conditioners in Ghana	In process	3
NM0074: Optimisation of Clinker use and energy conservation through technical improvement in the Ramla Cement Plant in Israel	C	4
NM0077: Shell Fuel Switching and Cogeneration Project	C	4
NM0078-rev: Conversion of single-cycle to combined cycle power generation in Ghana	In process	2
NM0079-rev: Taishan Huafeng Cement Works Waste Heat Recovery and Utilisation for Power Generation Project	In process	4
NM0080: Natural gas based grid connected major combined cycle power generation project for Torrent Power Generation Limited at Akhakhol Gujarat	In process	2
NM0086: Petrotemex Energy Integration Project	C	4
NM0087: Shri Bajrang WHR CDM Project	C; in ACM	4
NM0088: Jorf Lasfar heat recovery enhancement for power project	A; in ACM	4
NM0089: CECL´s Natural Gas based Engine Fired Captive Power Plant in Tamilnadu, India	C	2
NM0092-rev: Transalloys Manganese Alloy Smelter Upgrade & Energy Efficiency Project	In process	4
NM0095: ACC New Wadi Blended Cement Project	In process	4
NM0096: Energy Efficiency Improvements - Hou Ma District Heating, Shanxi Province, P.R.C.	C	1[3]
NM0097: Improvement in recovery of black liquor solids through Oxygen-Delignification and Free Flow Falling Film Evaporator and its use for steam generation in Soda Recovery Boiler	C	4
NM0099: Energy Efficiency Improvement in a Cement Plant at Jaypee Associates (Cement), Madhya Pradesh, India	C	4
NM0100: Electric motor replacement program in Mexico	C	3

[3] Resubmission of NM0058

NM0101: Grasim baseline methodology for the energy efficiency improvement in the heat conversion and heat transfer equipment system	C	4
NM0103: Andijan District Heating Project	C	1[4]
NM0105: Bus Rapid Transit System for Bogotá, Colombia: TransMilenio Phase II to IV	In process	NA[5]
NM0106: Optimisation of clinker use in the Ramla Cement Plant in Israel through investment in grinding technology	In process	4[6]
NM0107: Waste Gas-based cogeneration system for power & steam generation	In process	4
NM0112: Increased electricity generation from existing hydropower stations through Decision Support System optimization	In process	2
NM0113: Mondi Gas Turbine Co-generation in Richards Bay, South Africa	In process	4
NM0114: Improved Efficiency of Electrical Power System Generation through Advanced SCADA Control Systems and Related Energy Management Protocol	C	2

[1] Type definitions (as done in small scale project rules)

1. Supply side energy efficiency improvements for transmission and distribution
2. Supply side energy efficiency improvements - generation
3. Demand-side programmes for specific technologies
4. Energy efficiency and fuel switching measures for industrial facilities
5. Energy efficiency and fuel switching measures for buildings
6. Energy efficiency and fuel switching measures for agricultural facilities and activities

Out of the 43 submitted energy efficiency methodologies 7 have been approved, 21 have been rejected and 14 are still in process, i.e. either a final EB decision has not yet been taken or the rating was a B and the project participants are free to resubmit their improved methodology. One methodology from the list (NM0033) was rated B by the Executive Board, but has never been resubmitted.

Obviously, small-scale project categories have not been developed for large-scale methodologies and do not cover all possible project types. Nevertheless, the small-scale project categories have been used for the purpose of illustrating the current coverage of project types by the submitted methodologies.

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[4] Resubmission of NM0046

[5] Resubmission of NM0052

[6] Resubmission of NM0074

The bulk of methodologies has been submitted for energy efficiency and fuel switching measures for industrial facilities. None has been submitted for buildings or agricultural facilities and activities. Apart from that, methodologies have been submitted for supply side energy efficiency improvements. The majority of those methodologies has been designed for electricity generation project activities (7) while transmission and distribution project activities received less attention (4). Very few demand-side management (DSM) methodologies have been submitted (2). So far, submissions have only been successful regarding energy efficiency and fuel switching measures for industrial facilities, as well as supply side energy efficiency improvements for electricity generation. All proposals for district heating have been rejected. No proposal for transportation has been accepted, one methodology still being in process. One of the two DSM methodologies has been rejected; the other one is still in process. The transportation project activities (2) could not be classified with the existing project types.

In total, more than a quarter of all methodologies submitted to the Executive Board has been designed for energy efficiency measures and accordingly, one quarter of all currently approved methodologies covers energy efficiency project activities. Although the potential for energy efficiency improvements is considered to be very large (IEA, 2005), the approval of energy efficiency methodologies addressing other project activities than those in the industrial sector lags behind.

2.2 Analysis of the shortcomings of energy efficiency methodologies not approved by the EB

2.2.1 General shortcomings

Most proposals fail because of very general shortcomings, which could easily be avoided. The most common reason why a methodology is rejected consists in a lack in **transparency and conservativeness**. Transparency[7] is a meta-criterion which is dependent on the fulfilment of many other factors such as good drafting, clear explanations, consistency and verifiable[8] information and data. Conservativeness[9] is achieved when the design of the methodology leads to relatively low emission

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[7] E.g. NM0003, NM0031, NM0033, NM0044, NM0046,NM0047, NM0052, NM0100 and NM0103 deficient

[8] E.g. NM0064 and NM0071 deficient

[9] E.g. NM0003, NM0017, NM0018, NM0037, NM0077, NM0080, NM0086, NM0088, NM0096, NM0100, NM0101, NM0103 and NM0105 deficient

reductions. Regarding the baseline setting, algorithms and formulae provided, key assumptions made and data used, relevant **uncertainties**[10] should be identified and their impact (low, medium, high) should be estimated. For instance, the uncertainty in the district heating methodology NM0096 is very high, when design thermal ratings are chosen as indicators for the use of individual heat devices. High uncertainties considerably reduce the quality of a methodology, and thereby, threat its approval. **Quality assurance and quality control measures**[11] are intended to reduce uncertainty related to monitored values and are therefore of great importance.

Formal shortcomings should be avoided. This refers to submissions leaving out relevant aspects[12], to inconsistencies in the methodology[13] and badly drafted[14] proposals (affecting the transparency of the methodology and even prejudicing the reader against the methodology). Changes requested by the Meth Panel have to be made, when a methodology is to be resubmitted[15], because the Meth Panel is not going to treat the methodology less stringently just because it has been presented for the second time.

Of course, a methodology can also be rejected because it deals with a topic which in the meantime has been covered by an approved methodology.[16] In this case, the rejection does not necessarily mean that the proposal was of low quality.

Applicability of the methodology: It is the idea of a methodology to define proceedings which are directly applicable to project activities. Thus, the scope should not be too broadly[17] or too narrowly[18] defined. The applicability conditions

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[10] E.g. NM000, NM0018, NM0031, NM0033, NM0049, NM0079, NM0080, NM0096, NM0097, NM0100 and NM0101 deficient

[11] E.g. NM0018, NM0031, NM0086, NM0089, NM0096, NM0100, NM0101 and NM0103 deficient

[12] E.g. NM0003, NM0031, NM0033, NM0049, NM0058, NM0059, NM0086, NM0087, NM0088, NM0089, NM0092, NM0099, NM0100 and NM0103 deficient

[13] E.g. NM0031, NM0045, NM0096, NM0099 and NM0101 deficient

[14] E.g. NM0003, NM0044, NM0046, NM0049, NM0052, NM0058, NM0059, NM0064, NM0070, NM0077, NM0080, NM0086, NM0087, NM0089, NM0099 and NM0100 deficient

[15] E.g. NM0071 deficient

[16] For instance, this happened in the case of NM0087.

[17] E.g. NM0031, NM0046, NM0064, NM0074 and NM0097 deficient

[18] E.g. NM0003, NM0044, NM0059, NM0089, NM0097 and NM0100 deficient

should be defined appropriately[19] and their scope should also not be too broad[20] or too narrow. If the methodology develops models to be used, these have to be transparent (no black-box model), complete, accurate and consistent with the methodology[21].

Baseline: The selection of the baseline approach (48 a, b or c) should reflect the rationale of the methodology[22] and avoid contradictions between the procedure of baseline definition and the additionality test. The baseline setting has to take two main aspects into account. First, the selection process should be described in detail providing a tool to identify the baseline.[23] Potential changes in legal requirements and policies should be taken into account.[24] Second, the baseline has to be defined in detail.[25]

Additionality: An additionality tool has to be provided; otherwise the methodology cannot be approved.[26] The aim is to demonstrate that emission reductions are achieved and that the baseline scenario is not the scenario of the project activity. This part of the methodology is now posing less problems as the EB adopted a consolidated additionality tool at its 16ths meeting in October 2004 which provides guidance[27]. However, the application of the tool should be clear. For instance, the baseline setting should not be neglected by the proposal, because these aspects are not sufficiently covered by the additionality tool.[28] References made to the additionality tool should further be unequivocal.[29] The additionality tool can also be applied partially or with modifications. It is, however, strongly recommended to clearly state and justify the partial use and the modifications made. Obviously,

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[19] E.g. NM0074, NM0087, NM0092, NM0096 and NM0101 deficient

[20] E.g. NM0087 deficient

[21] E.g. NM0071 deficient

[22] E.g. NM0003 deficient

[23] E.g. NM0031, NM0037, NM0046, NM0049, NM0052, NM0058, NM0064, NM0070, NM0071, NM0072, NM0074, NM0079, NM0086, NM0087, NM0088, NM0089, NM0092, NM0096, NM0097, NM0099, NM0100, NM0101 and NM0114 deficient

[24] E.g. NM0031, NM0078, NM0092 deficient

[25] E.g. NM0003, NM0046, NM0059, NM0071, NM0074, NM0086, NM0087, NM0088, NM0089, NM0107 and NM0113 deficient

[26] E.g. NM0003, NM0018, NM0052 and NM058 deficient

[27] Formally, the consolidated additionality tool is not mandatory but just a recommendation. However, it has become a de facto standard.

[28] E.g. NM0072, NM0074, NM0089, NM0100 and NM0114 deficient

[29] E.g. NM0071 deficient

project participants are still free to propose new additionality tools, but when considering this option, it has to be taken into account that the present additionality tool somehow sets minimal standards.[30]

Project boundary and leakage should be defined consistently[31]. All emission sources under control of the project developers should be included in the project boundary. Project participants should check whether all relevant gases have been included, and whether the physical and spatial definition covers all processes and areas under control.[32] A system boundary should be defined for methodologies which take into account effects on another system (e.g. the electricity grid). The definition of leakage[33] is dependent on the boundaries. It is a weakness of a methodology, when leakage is difficult to grasp. If the boundary covers all emission sources, leakage does not exist. If this is not the case, the sources of leakage should be clearly definable and measurable.[34] The procedures to treat leakage have to be specified in detail. Positive leakage can always be excluded as this is conservative. Minor sources of negative leakage can be excluded for simplicity, but it has to be demonstrated that the sources are actually minor and that it is not efficient to monitor them.

As reality is complex and goes beyond the scope of a methodology which has to be developed for determined constellations, **assumptions** have to be made to reduce this complexity and define the conditions under which the methodology is valid. But if wide applicability of a methodology is intended, the aim should always be to define as many assumptions as necessary and as few as possible, i.e. the right amount and scope of assumptions. All assumptions made have to be transparent and justified.[35]

When it comes to the **calculation of emission reductions**, parameters have to be defined in order to make the methodology applicable to different project activities.

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[30] E.g. NM0018, NM0031, NM0037, NM0042, NM0044, NM0045, NM0046, NM0049, NM0059 NM0064, NM0092, NM0097 and NM0103 deficient

[31] E.g. NM0003 deficient

[32] E.g. NM0003, NM0031, NM0046, NM0080 ,NM0087, NM0088, NM0092, NM0096, NM0097 and NM0099 deficient

[33] E.g. NM0097, NM0100, NM0103 and NM0113 deficient

[34] E.g. NM0003, NM0046, NM0052, NM0058, NM0071, NM0087, NM0088 and NM0089 deficient

[35] E.g. NM0003, NM0031, NM0044, NM0046, NM0049, NM0052, NM0058, NM0059, NM0070, NM0071, NM0086, NM0088 and NM0089, NM0100, NM0107 and NM0114 deficient

The parameters should be transparent[36], cover all relevant aspects[37] and consist in adequate control variables[38], for instance account for changes over time[39]. In order to enable the user of the methodology to carry out the necessary calculations, equations have to be provided[40]. The algorithms have to follow the logic of the methodology[41], should be complete[42] and transparent[43], adequate[44], free of errors[45] and consistent in their symbols.[46] As the equations consisting of parameters have to be filled with data when the methodology is applied to concrete project activities, it has to be specified, what kind of data should be used, how it can be obtained and how often it should be recorded[47]. As data availability[48] varies among the project activities, it is positive to define a hierarchy of data sources[49]. For instance local data is to be preferred to national data and national data to global data and default values. However, under high uncertainty, the conservative hierarchy would probably be exactly the other way around.[50] Therefore, justifications have to be provided. In general, data should be of high quality and low uncertainty[51], it should be recent, representative[52], objective[53] and complete.[54] The data vintage has to be chose appropriately.[55] The monitoring methodology has to be adequately linked to the data[56], should cover all aspects pointed out by the baseline methodology[57] and

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[36] E.g. NM0099 deficient

[37] E.g. NM0058 and NM0106 deficient

[38] E.g. NM0046, NM0049, NM0058 and NM0086 deficient

[39] E.g. NM0033 and NM0046 deficient

[40] E.g. NM0003 and NM0031 deficient

[41] E.g. NM0106, NM0114 deficient

[42] E.g. NM0096 deficient

[43] E.g. NM0037, NM0045, NM0097 and NM0099 deficient

[44] E.g. NM0044 and NM0080 deficient

[45] E.g. NM0017 and NM0099 deficient

[46] E.g. NM0044 and NM0086 deficient

[47] E.g. NM0031, NM0045 and NM0089 deficient

[48] E.g. NM0045, NM0070 and NM0088 deficient

[49] E.g. NM0072, NM0078, NM00088 and NM0107 deficient

[50] E.g. NM0018 deficient

[51] E.g. NM0018, NM0033 and NM0096 deficient

[52] E.g. NM0114 deficient

[53] E.g. NM0031 and NM0105 deficient

[54] E.g. NM0046, NM0049, NM0052 and NM0059 deficient

[55] E.g. NM0040, NM0088, NM0101 and NM0112 deficient

[56] E.g. NM0003 and NM0031 deficient

[57] E.g. NM0018, NM0031, NM0033, NM0037, NM0044, NM0045, NM0058, NM0080, NM0086, NM0087, NM0092 and NM0096 deficient

be as thorough as possible (i.e. always measure when possible)[58]. The frequency of the monitoring has to be specified.[59]

2.2.2 Shortcomings specific to energy-efficiency methodologies

Many energy efficiency methodologies deal with **boiler efficiency** or **motor efficiency**. One proposal[60] was not directly approved because the efficiency measurements were not carried out before and after the intervention as per international practice. In the case of a proposed energy integration project[61], the use of historically recorded efficiencies without justification was not accepted. Boiler efficiency could be estimated by the direct or indirect method[62] (as in AM0018, which will be described in chapter 4). It has to be specified under which conditions each of these two approaches is more appropriate. The most sophisticated approach to reflect the operational efficiency is to measure the heat input into the boiler and heat output of the boiler.

To set the baseline conservatively, the highest efficiency should be chosen out of those measured before project implementation (ex-ante), during implementation/operation and the one specified by the manufacturer (e.g. nameplate data).[63] When the measurements are undertaken at full load, the results are the most conservative[64].

Changes in efficiency may occur due to changes in the fuel used[65] and have to be monitored. But conversely, the relationship between boiler efficiency and fuel consumption is not sufficiently close to make the monitoring of the fuel consumption dispensable.[66] It is also too vague to use the estimated effect of an increased power factor on power consumption instead.[67] All the same, baseline power consumption should not be estimated by e.g. the steam produced by the

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[58] E.g. NM0045, NM0079 and NM0103 deficient

[59] E.g. NM0100 deficient

[60] E.g. NM0017 deficient

[61] E.g. NM0086 deficient

[62] E.g. NM0037 deficient

[63] E.g. NM0100 and NM0107 deficient

[64] E.g. NM0018 deficient

[65] E.g. NM0037 and NM0086 deficient

[66] E.g. NM0037 deficient

[67] E.g. NM0044 and NM0114 deficient

waste heat recovery system.[68] Thus, fuel consumption[69] as well as power consumption should be monitored explicitly. Regarding motor efficiency, it is important to account for possible variations due to different climatic conditions.[70]

Equivalence of service: A common problem of methodologies dealing with transportation and district heating is the **rebound effect**. An efficiency improvement is likely to engender a better service resulting in higher consumption[71], especially in case of suppressed demand[72]. This has to be taken into account when calculating the baseline emissions. A similar topic is addressed when it comes to **increases in capacity** which also concerns industrial facilities[73]. It is not sufficient to state that no capacity increase is taking place without providing a justification[74], why the improved service does not lead to an implicit capacity expansion. Thus, a methodology is conservative either if it ensures equivalence of service (or product types), or if it allows to calculate and deduce the emissions from capacity increase. Further, it has to be ensured that emission reductions due to process changes (e.g. decrease in production) are not accounted for.[75]

Remaining lifetime of the baseline equipment: To avoid overestimate of the emission reduction, the remaining lifetime of the baseline appliances has to be taken into account.[76] It should be differentiated between two constellations:

a) No changes during the crediting period: In this case, it should be demonstrated that the technical lifetime of the equipment is at least as long as the crediting period[77]. For instance, the remaining lifetime of a boiler or motor should define the upper bound for the crediting period. The remaining lifetime of the equipment should not be extended by the project activity[78].

b) Changes during the crediting period: Changes in baseline equipment should be covered by the methodology. The effects of replacement of equipment in the

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[68] E.g. NM0087 and NM0088 deficient

[69] E.g. NM0037 and NM0049 deficient

[70] E.g. NM0100 deficient

[71] E.g. NM0096 and NM0103 deficient

[72] E.g. NM0052 deficient

[73] E.g. NM0017, NM0018, NM0059, NM0064, NM0088 and NM0100 deficient

[74] E.g. NM0045 and NM0046 deficient

[75] E.g. NM0086, NM0087 and NM0095 deficient

[76] E.g. NM0033, NM0070, NM0088, NM0097 and NM0100 deficient

[77] E.g. NM0088 deficient

[78] E.g. NM0070 deficient

baseline scenario should be calculated and taken into account when calculating the emission reductions.[79] The concrete time schedule of the replacement should be indicated.

Otherwise, an overestimation of baseline emissions is likely.

When conducting a financial analysis (e.g. in order to select the baseline scenario or to prove additionality), the entire equipment lifetime for both project activity and baseline scenario has to be covered.[80]

Special attention has to be paid to accounting for **net savings/improvements** only.[81] For instance regarding water pumping[82], the water intake has to be monitored apart from the water output to account only for the incremental savings. In case of waste heat recovery, it has to be examined whether all waste heat is captured in the recovery boiler. In addition, if other fuels can be used for auxiliary firing, the outlet waste gas flow rate must be monitored.[83] Emission reductions from retrofits undertaken after the implementation of the project activity have to be deduced.[84]

Renewable **biomass** is considered a zero emission source. Therefore, baseline emissions e.g. from methane flaring or decay should not be accounted for. In order to avoid leakage, the biomass should be available in abundance (e.g. 1.5 times the quantity needed to cover the whole demand).

When the monitoring consists in **sampling**, the definition of the sampling period and sample size[85] has to be clear. If extreme values are to be excluded from the calculation, it has to be specified, how to identify the normal range.[86] Sample units should be representative.[87]

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[79] E.g. NM0033, NM0097 and NM0100 deficient
[80] E.g. NM0033 andNM0099 deficient
[81] E.g. NM0100 deficient
[82] E.g. NM0042 deficient
[83] E.g. NM0031 deficient
[84] E.g. NM0037 deficient
[85] E.g. NM0072 deficient
[86] E.g. NM0037 deficient
[87] E.g. NM0003, NM0037, NM0100 and NM0103 deficient

2.2.3 Project-type-specific shortcomings:

In **cement industry**, several product-specific issues can come to concern: The measurement (samples) of the CaO content of the clinker can be required to calculate the CO_2 from calcination.[88] When blended cement is produced, the units should be expressed in tonnes of blended cement (e.g. PPC) and not in tonnes of clinker. The exact composition of the blended cement has to be defined for the respective market. A common practice test has to refer to blended cement only and the threshold has to be conservative. The highest percentage of blend in the relevant market should set the baseline. In case of unreliable data, laboratory analysis should be undertaken.[89] Policies and industry norms have to be addressed regarding requirements for blended cement.[90] Differences in amount and quality of the cement produced in the baseline scenario and in the project activity scenario have to be taken into account (for equivalence of service).[91] Leakage assessment has to deal with potential emission sources from increased use of blended cement for the same application due to reduced quality and from former clients buying non-blended cement now from other companies.[92] Regarding the incentives for producing blended cement, it has to be examined (either investment or barrier analysis) whether the cheaper additives (e.g. fly ash in comparison to limestone) may create economic benefits and how decisive they are.[93] If improvements in the heat conversion and transfer system are pursued, the composition of raw feed and clinker should be monitored, as fly ash or other calcinated materials in the raw feed could decrease heat consumption. Changes in fuel choice should be monitored, too, because biomass fuels for instance can increase the heat consumption.[94]

Energy efficiency improvements in **district heating** are characterised by the following methodological specialities: In case an ex-ante fixed baseline is not realistic, changes during the crediting period should be monitored.[95] Thus, the baseline should not rely on ex-ante estimations of key parameters which evolve dynamically, such as the level of activity, insulation standards, losses in the district

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[88] E.g. NM0033 deficient

[89] E.g. NM0045 deficient

[90] E.g. NM0047 and NM0103 deficient

[91] E.g. NM0074 and NM0095 deficient

[92] E.g. NM0095 deficient

[93] E.g. NM0095 deficient

[94] E.g. NM0101 deficient

[95] E.g. NM0103 deficient

heating system, boiler efficiency, the load factor for hot water[96] and the use of individual heating systems.[97] If monitoring is done by sampling, surveys should be conducted ex-ante and during the crediting period.[98] If in the baseline, a shifting of stoves and furnaces to new coal boilers takes place, the timing has to be identified.[99] There is a risk of double counting when the impact of DSM programs cannot be separated from the efficiency gains generated by the project activity.[100]

Transportation is faced with project-specific problems, too. The submitted proposals mostly failed because of conceptual gaps (e.g. taxis not included), data gaps (e.g. number of trunk buses, vehicle replacement, number of persons transported in the system, modal switch) and bad monitoring, estimating data which should be measured (e.g. fuel consumption rate of trunk buses, daily distance feeder buses and fuel consumption of feeder buses would be available from transport operating companies).[101] If a scrappage rate is indicated for older vehicles, the estimate should at least be the average value and not the minimum.[102]

Apart from the recommendations made regarding the treatment of efficiency and remaining lifetime, methodologies for **electric motor replacement** have to take into account the following aspects: As motor characteristics may be of a wide range when an entire market is concerned, the motors should be classified in subgroups depending on operating hours, loads, remaining motor life and baseline efficiencies. The operation at nameplate efficiency of new replaced motors should be monitored.[103] In case of burnout, motor efficiency may be reduced due to local rewinding. This problem affects old and new motors equally.[104] It is not conservative to simply assume that all motors have been displaced due to the incentive (no free riders). Such a statement has to be proven[105] or free riders have to be considered as leakage.

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[96] E.g. NM0096 deficient

[97] E.g. NM0046, NM0058 and NM0096 deficient

[98] E.g. NM0103 deficient

[99] E.g. NM0058 deficient

[100] E.g. NM0046 deficient

[101] E.g. NM0052 deficient

[102] E.g. NM0103 deficient

[103] E.g. NM0100 deficient

[104] E.g. NM0100 deficient

[105] E.g. NM0100 deficient

Regarding **DSM programs** in general, it has to be assured that no double-counting from multiple potential claimants (end user, manufacturer) is taking place.

Efficiencies of **electrical power systems** may be influenced by many factors such as weather, availability of hydro plants, T& D constraints (losses from old, but also from new equipment), fuel availability, electricity trade, electricity production from independent power producers and plant operating changes. Impacts of new capacity additions on the load factors and emission intensities of the operating plants should be considered.[106]

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[106] E.g. NM0114 deficient

3.   Characteristics of approved methodologies

In the following, the approved energy efficiency methodologies will be described in detail.

3.1   AM0014: Natural gas-based package cogeneration

AM0014 has been the first energy efficiency methodology approved by the Executive Board. It covers supply side energy efficiency improvements for heat and electricity production through natural gas-based package cogeneration. Although the project activity encompasses the installation of new equipment, approach 48a), "existing actual or historical emissions as applicable", is chosen.

In the absence of the project activity, the industrial facility would meet its energy needs with purchases from power and gas companies. The baseline is selected out of a list of **6 scenarios**: the frozen-efficiency scenario, improved equipment at the time of replacement, immediate upgrade of boiler efficiency, reduced energy demand through improved end-use efficiency, installation of a cogeneration plant, and third party package cogeneration. As the methodology conservatively estimates high boiler efficiency, the first three scenarios can directly be excluded. The **additionality test** for cogeneration is divided into three sections. First, technological barriers in the country are assessed. The project activity is considered additional, if less than 10% of the economic cogeneration potential has been implemented. If the project activity does not pass the test (either because more than 10% of the potential has been reached or because the test cannot be carried out due to lack of data on the economic potential) the next test applies. The project activity is considered to be additional, if the installed cogeneration capacity is not greater than 5% of the total thermal generating capacity, not greater than 500MW, or not comprising more than 25 plants. The second additionality test refers to institutional barriers to cogeneration in general (institutional barrier A). If preferential tariffs, financing and/or fiscal benefits exist for cogeneration, there is no institutional barrier A. If such advantages do not exist, it has to be analysed whether the project developers face economic penalties. For instance, electricity purchasers often oblige their customers to contract the maximum demand charge for the whole year. This provokes very high additional costs to the project developer, as any plant has to interrupt operation to conduct to routine maintenance and can be object to forced outage. If project developers are in such a way disadvantaged, the project activity faces the institutional barrier A. The third of the additionality tests examines

whether there are specific institutional barriers for package cogeneration (institutional barrier B). If no third party package cogeneration has been installed at industrial facilities, and if package cogeneration does not exceed 20 recent installations or 5% of the total installed thermal generating capacity, the project activity faces the institutional barrier B.

Baseline emissions comprise the greenhouse gases from combustion of natural gas (i.e. CO_2, CH_4, N_2O), CH_4 leaks from natural gas production and leaks in the gas pipelines as well as CO_2 emissions from grid electricity generation. It has to be differentiated between the **heat** and the **electricity** demand:

The quantity of heat which would have been generated through the combustion of natural gas in the baseline is estimated by dividing the annual heat output of the cogeneration system through the boiler efficiency. In order to calculate a conservative baseline, the **boiler efficiency** is assumed to be high (0.90). The annual heat output is estimated by multiplying the heat output rate (system's specifications), with the estimated annual operating hours (engineering study) of the cogeneration system.

Four emission factors have to be determined for the calculation of the baseline emissions from heat production: The factor for CO_2 emissions from natural gas combustion for heat supply has to be taken from existing data sources. The first choice is data from **national GHG inventories**. If not available, fuel and technology specific **IPCC** data should be used. In the worst case, **IPCC** data for similar fuel types and technologies can be used. The emission factors for CH_4 and N_2O are taken from **IPCC** data, too, preferably the fuel- and technology-specific ones. The emission factor for CH_4 emissions from natural gas production and leakage in transport and distribution should be taken from national estimates if available, and otherwise from **IPCC** estimates of fugitive emissions from oil and natural gas activities. Finally, the emission factors are transferred into CO_2 equiv.

The quantity of electricity which would have been supplied to the industrial plant is determined by the cogeneration electricity output (monitored) and the CO_2 emissions factor for electricity from public supply. For an ex-ante estimate of the electricity output, the net power output capacity of the cogeneration system is multiplied with the annual operating hours of the cogeneration system. The

emission factor for the electricity supplied in the baseline is estimated following ACM0002 and AMS-I.D.

The emissions of the project activity comprise those of the combustion of natural gas in the cogeneration facility (CO_2, CH_4, N_2O) as well as CH_4 emissions from natural gas production and leakage in transport and distribution.

The boundary of the baseline and the project activity is not explicitly defined in the methodology.

In the monitoring methodology, key data is measured and quality assurance and quality control procedures are specified for them.

3.2 AM0017: Steam system efficiency improvements by replacing steam traps and returning condensate

AM0017 deals with the improvement of energy efficiency at industrial facilities by new steam traps and utilisation of condensate. This methodology is designed for retrofits and follows approach 48a).

There is **no list of alternatives** provided to select the baseline scenario. The methodology is based on the assumption that the baseline scenario is the continuation of the current practice which is monitored using a **control group**. To collect the data required for the methodology, a survey has to be carried out by trained technicians among the plants of the control group and the one of the project activity prior to implementation and during operation of the project activity (at least annually). The data has to be recent (not older than 12 months) and documented transparently. Categories for testing the operation conditions are specified (blow thru, leaking, rapid cycling, plugged, flooded, out of service, not tested). The plants of the control group have to match best with the characteristics and conditions of the project plant, especially regarding the sector (same or similar), the stream generation capacity (best matches), the location (same or similar) and the age (similar age or more recent). The selection of the control group plants has to be justified and deviations have to be explained.

The **additionality test** consists of four steps. First, it has to be demonstrated that the project activity is not common practice. Therefore, a survey has to be conducted in the project plant as well as in five similar plants. The additionality test focuses on

three aspects for which the data has to be collected prior to the implementation of the project activity: steam trap failure rates, the existence and shape of maintenance programs and condensate return rates. The project activity is not considered additional when for the plants in the control group the average steam trap failure rates are more than 5% lower, the average relative condensate return is more than 5% higher and/or a steam trap maintenance program is in place or planned for the project activity plant. As a next step, legal requirements and sectoral circumstances regarding steam trap maintenance programs are examined. If the project activity is likely to be required by national/sectoral programs, it is not considered to be additional. Then, a barrier analysis is supposed to be undertaken. The project developer has to provide transparent information and documented evidence that the identified barriers are prohibitive. A list with examples including investment barriers, technological barriers, barriers to prevailing practice and other barriers follows. In the last step, it has to be demonstrated how the benefits and incentives of the CDM (e.g. financial benefits, institutional benefits, technical and capacity building benefits) help to overcome the prohibitive barriers.

Emission reductions mainly originate from decreased combustion of fossil fuels due to steam savings from reduced steam losses and returning condensate, but also from energy saved for the pumping of makeup water. However, the project activity also leads to new emissions due to the pumping, treatment and purification of the returning condensate. Only CO_2 emissions are accounted for.

For calculating the **loss of a steam trap**, a formula is provided which has been developed based on the Masoneilan approach, but which is more conservative. The key variables of this formula are the failure type factor (empirical value, estimate by the company 'Armstrong'), the service factor (depending on trap size in relation to actual load) and the flow coefficient (depending on the trap size). Apart from that, the operation hours of the trap as well as the pressure of the steam at the inlet and of the one of the condensate at the outlet are needed for the calculation. The equation is not valid for outlet pressures which are less than half of the inlet pressure. In order to calculate the baseline losses of the steam traps **in a conservative manner**, either the actual operation time or the operation time prior to the implementation of the project activity should be used, whichever is smaller. The savings are calculated as the difference between the baseline losses and the losses of the project activity.

To determine the **savings due to returned condensate** the following data is needed: the quantity of condensate returned and the quantity of steam generation of all plants considered; and the enthalpy of condensate (as a function of temperature, pressure and vapour fraction), the quantity of makeup water, the enthalpy of makeup water (as a function of temperature), the quantity of steam generation and the enthalpy of steam (as a function of temperature and pressure) of the project activity plant. For an ex-ante estimate, the average values for the last two years are used. During operation, the actual average values are to be monitored. Then, the share of steam saved per steam generated can be calculated for the baseline and for the project scenario. The difference of the shares is the relative increase in savings. The savings in absolute terms are obtained by multiplying this ratio with the quantity of steam generated by the boiler of the project plant. If the formula leads to higher steam savings than the absolute difference between the baseline and the project scenario (e.g. because the operation/capacity utilisation during the project activity is lower than in the baseline), the lower value has to be used **for conservativeness**, unless it can be shown that the result of the formula is more appropriate.

Leakage is not accounted for, as all relevant emissions are included into the calculation.

The **emission reductions from steam savings** are determined by the emission factor of the fuel combusted in the boiler times the increase in steam savings which are multiplied with the enthalpy of steam leaving the boiler in the project scenario (as a function of temperature and pressure) and divided by the boiler efficiency. In order to obtain **conservative estimates**, the boiler efficiency has to be the highest of the following three: the measured efficiency prior to the implementation, the one during operation and the information provided by the manufacturers. The net calorific value of the respective fuel should be determined by local or national data if considered reliable, otherwise IPCC default emission factors have to be used.

To complete the calculation of emission reductions, the **effects on electricity consumption** have to be taken into account. The increase in returning condensate may engender a lower power consumption to pump makeup water. The data may either be obtained from the local water utility or has to be measured. However, an increase in power consumption may also result from the returning condensate due to pumping, treatment and purification processes. The data has to be measured at

the project site. A **conservative value** for the condensate return in the baseline scenario should be derived from the survey results prior to implementation, i.e. either the value of the control group or the one of the project activity should be chosen, whichever is greater. If the electricity is purchased from the grid, an average emission factor of the grid is to be used, which should be provided by the supply company as long as it can be demonstrated, that it has been calculated in a consistent, transparent and accurate way. Otherwise, the generation-weighted average of all sources should be calculated. If the electricity is generated on-site, a specific project emission factor is to be used. The calculation should be based on the most recent data on fuel consumption, electricity generation and system losses.

The net emission reductions consist in emission reductions from steam savings plus/minus net emission changes from electricity consumption.

The boundary of the baseline and the project activity is not explicitly defined in the methodology.

As a final observation it has to be pointed out that AM0017 makes explicit that the function of the DOE is to verify judgements of the project developers.

3.3 AM0018: Steam optimisation systems

AM0018 deals with the improvement of energy efficiency at industrial facilities through reduced steam consumption. This methodology is designed for retrofits and follows approach 48a).

The methodology uses the additionality tool. The baseline has to be selected out of a **set of alternatives**; however, the methodology is not applicable to other baseline scenarios than the continuation of current practice.

The project boundary should cover the steam generator, the electricity sources if additional consumption is required by the project activity, and the process area where the steam consumption is to take place.

The baseline energy efficiency is defined in form of a **benchmark**: SSCR (Specific Steam Consumption Ratio) describes the steam consumption per product output. The SSCR of the baseline is estimated and the one of the project activity is monitored. The baseline output (shift-wise or batch-wise) is estimated based on

historical data. **Extreme values** have to be **excluded**, i.e. when the fluctuations in production exceed the normal production range (+/-5% of nameplate capacity) as the specific steam consumption could be reduced by increased production levels. Seasonal demand variations should not be excluded; on the contrary, the data vintage should cover those effects. If the demand does not vary seasonally, a data vintage of one month is sufficient. The representative values can be expressed per day or per batch, if the time to produce a batch is longer than a day or if per day, a not integer number of batches is produced. For those values, the steam consumption is then deduced The SSCR is the representative steam consumption divided by the representative production.

The output (shift-/batch-wise) as well as the steam production (hourly) of the project activity have to be monitored (logbook or Distributed Control System). Only the representative values are used and averaged. Out of these two factors, the SSCR for the scenario of the project activity is determined.

As the SSCR is a ratio, it has to be multiplied with the monitored output of the project activity to reflect the net steam savings. To obtain the net daily reduction in energy (consumption), the savings are multiplied with the net enthalpy of steam from the boiler, consisting in the total enthalpy minus the heat content of feed water. To obtain the daily reduction in input energy, the net daily reduction in energy is divided by the efficiency of the boiler (to be monitored periodically either by the direct method, i.e. the Input-Output-Method, or by the indirect method, i.e. the Input-Loss-Method as per British Standard BS-845, but the latter is not eligible in case of mix fuel). The emission reductions from steam savings are calculated by multiplying the daily reduction in input energy with the emission factor. If several fuels are used the respective emission factors are weighted by their daily share.

However, additional emissions may occur due to higher electricity consumption by the optimised processes. The emissions may be estimated the following: The electrical consumption has to be **monitored** shift- or batch-wise. If this is not possible, **nameplate data** of the electricity consuming device has to be used as a proxy. As a next step, the average daily consumption of electricity is determined out of the representative consumption values and the number of shifts or batches per day. The average is divided through the **minimum efficiency** (to be **conservative**) of the electricity generating system (historical data) to obtain the daily input energy into the electrical energy source. Depending on how the energy used is generated,

the emission factor has to be chosen. The daily input energy is multiplied with either the carbon emission factor for the respective fuel (**IPCC default value**) in case of captive power generation, or with the carbon emission factor of the selected grid (**combined margin method**). These additional emissions have to be subtracted from the emission reductions calculated above. Possible steam savings due to retrofits which are not part of the CDM project activity have to be deducted from the emission reductions.

Leakage is not accounted for, as all relevant emissions are included into the calculation.

3.4   AM0020: Baseline methodology for water pumping efficiency improvements

AM0020 deals with the improvement of water pumping efficiency. Methodologically, it consists in an extension of **ACM0002**. AM0020 is designed for retrofits and follows approach 48a). The methodology is not applicable to entirely new equipment to increase capacity.

To test the **additionality** of the project activity, the additionality tool is applied. Special attention should be paid to procedures, policies and performance related contracts which could require efficiency measures.

The **boundary** can encompass a major pumping station, the water supply system or even the entire municipal water system. In case of multiple schemes being upgraded, separate monitoring has to be implemented for each scheme. The boundary should reach from the point where the water enters the system to the point where it is delivered to. All equipment under the control of the project participants (e.g. supplemental pumps, booster stations) should be covered. Pumps not under the control of the water utility should only be included if they are needed for the implementation project activity and exclusively running for the defined system. Regarding greenhouse gases, only CO_2 has to be covered. The system boundary is the electricity grid.

A **set of alternatives** to select a baseline scenario is **not part of the methodology.** The predetermined baseline scenario is the continuation of current practice. The ex-post measured water volume is multiplied with an ex-ante determined baseline efficiency ratio and the carbon emission factor of the electricity grid. The emission

factor is calculated following the combined margin method laid out in **ACM0002**. The emissions from the project activity are calculated by multiplying the total ex-post measured electricity consumption for moving the water to its destination and the grid emission factor. Leakage is not identified. The emission reductions are the result of baseline emissions minus project emissions.

3.5 ACM0003: Emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture

ACM0003 has been designed for partial fuel switch from fossil to alternative fuels in cement production and follows approach 48b). The methodology is not applicable to increases of capacity. The alternative fuels used have to be there in surplus (at least 1.5 times the quantity needed to meet the total demand of all users) to avoid leakage.

The **boundary** encompasses clinker production and all related processes. Regarding the production process, only CO_2 emissions have to be considered. This includes CO_2 emissions from non-biogenic carbon of alternative fuels (unless it can be demonstrated that incineration is the dominant practice in the baseline). In addition, emissions from transportation of the alternative fuels (CO_2, CH_4 and N_2O) have to be included into the calculation, those occurring on-site as project emissions and those occurring off-site as **leakage**. It is assumed for the baseline scenario that biomass is burned on open fields (unless anaerobic decomposition can be demonstrated) and that waste is subject to anaerobic decomposition in landfills. These CH_4 emissions are treated as **leakage**.

The baseline scenario is selected out of **a set of alternatives** including the continuation of the current practice, different fuel mixes and varying degrees of fuel switches. The amount of fossil fuel used over the crediting period has to be estimated for each of the scenarios. All scenarios should be inline with the relevant policies and regulations. As it is assumed that the project developer pursues revenue maximisation, the selection of the baseline scenario can be based on a **financial analysis (NPV/IRR)**. The most cost-efficient scenario is then chosen to represent the baseline. A sensitivity analysis has to be carried out to substantiate the selection. Alternatively, the baseline can be defined through a **barrier analysis** as specified in the **additionality tool**. National, local and sectoral policies and circumstances have to be considered.

Due to the use of alternative fuels, the heat transfer efficiency in the production facility is reduced and the absorption of fuel ashes into clinker is hindered. This fact is accounted for by the introduction of a 'moisture penalty'. The moisture penalty is determined by a comparison of the production with and without use of alternative fuels at an average percentage of alternative fuel. The difference in specific heat consumption (with and without alternative fuels) has to be calculated. This is divided through a test share of heat input due to alternative fuels and multiplied with 10. To obtain the total moisture penalty, the moisture penalty is multiplied with the total clinker production and with the (monthly calculated) alternative fuel heat input share of total baseline heat input which is divided through 10 percent. The heat input of a fuel results from the quantity the fuel multiplied with its lower heating value.

The emissions from the use of alternative fuels are the quantities of the alternative fuels multiplied with the respective heating value and emission factor. The baseline emissions from fossil fuels displaced by the alternative fuels consist in the total heat provided by the alternative fuels reduced by the total moisture penalty and then multiplied by the emission factor of the fossil fuel (mix). In order to determine the emission factors in a **conservative way**, the lowest value of the following ones has to be adopted: the one monitored prior to validation, the one monitored during implementation and the hypothetical one of the baseline scenario. In addition, emissions due to on-site transportation of fuels occur. For alternative fuels, the emissions consist in the quantity of fuel used multiplied with a term composed of the emission factors for CO_2, CH_4 and N_2O, plus the fuel used for drying purposes times its heating value and its emission factor. These emissions have to be offset against the savings from reduced on-site transportation of fossil fuels. Therefore, the fuel savings are multiplied with the respective emission factor.

Finally, four types of **leakage** have to be considered: leakage due to burning of biomass, due to anaerobic decomposition of wastes, due to changes in fuel off-site transport and due to off-site preparation of alternative fuels. To calculate the baseline emissions from burning of biomass, the amount of biomass used as alternative fuel (which would have been burned in the baseline) is multiplied with the respective carbon fraction (estimated with **default values**), with the fraction which would have been released as CH_4 in open air burning, with the carbon to CH_4 conversion factor (16/12) and the GWP of CH_4 (24). Baseline emissions from anaerobic decomposition can only be claimed, if the landfill gas is not flared. The amount of

wastes used as alternative fuel (which would be landfilled in the baseline) has to be multiplied with the respective degradable organic carbon (DOC) content, with the portion which is converted to landfill gas (default 0.77), the CH_4 conversion factor, the fraction of CH_4 in landfill gas (default 0.5), the carbon to CH_4 conversion factor (16/12), the oxidation factor (default 0), the non-flared portion of the landfill gas and the GWP of CH_4 (21). To calculate the emissions from changes in off-site fuel transportation, the leakage from transport of alternative fuels has to be offset against the leakage from transport of fossil fuels. Therefore, the quantities of fuels used have to be divided by the respective average truck or ship capacity. Those fractions are then multiplied with the respective average round trip distance between the supply and delivery points and with the emission factor for fuel consumption due to transportation (calculated out of the emission factors of CO_2, CH_4 and N_2O in transport). The project emissions due to off-site preparation of alternative fuels is the sum of the fuel used times its heating value times the emission factor and the power consumption times the emission factor of power generation (refer to **ACM0002**).

3.6 ACM0004: Consolidated methodology for waste gas and/or heat for power generation

ACM0004 has been developed for electricity generation out of waste gas/heat. It is related to **ACM0002** and the **additionality tool** is applied. The approach (48a, b or c) is not specified. The methodology is applicable to new and existing facilities displacing fossil power from grid or captive generation, unless fuel is switched in the process of waste gas/heat generation after the implementation of the project activity.

The **boundary** includes CO_2 emissions from the combustion of auxiliary fuels (project scenario) and from the combustion of fossil fuels in grid plants and captive plants (baseline scenario). It covers the waste gas/heat sources, captive power generating equipment, auxiliary heat generating equipment and the grid plants.

The baseline is selected out of **a set of alternatives** which have to be in line with the legal and regulatory requirements and to be based on key resources available at the project site. Options can be excluded if evidence and supporting documents are provided. A list with suggestions is included. The **economically most attractive option** is to be considered as the baseline. As a next step, the additionality tool is applied to the baseline and the project scenario.

The only project emissions which can occur are those from the use of auxiliary fuels (for start-up, emergencies and additional heat generation). It is determined by the mass or volume of the fuel times the respective NCV, the emission factor, the carbon to CO_2 conversion factor (44/12) and the oxidation factor (**IPCC**). Apart from the oxidation factor, **local values** are preferable to country-specific values and to world-wide default values. The baseline emissions are equal to the net electricity supplied by the project activity multiplied with the emission factor for the electricity displaced. The self-consumption of the power plant has to be subtracted from the total electricity generated to obtain net electricity. The emission factors vary depending on the generation source. In case of captive power generation, the emission factor is determined by the CO_2 emission factor of the fuel divided by the efficiency of the captive power generation. This fraction is multiplied with the carbon to CO_2 conversion factor (44/12) and the TJ to MWh conversion factor (3.6/1000). For **conservativeness**, the boiler efficiency can either be set 100% of the NCV or the highest value has to be chosen out of the efficiency measured prior to the implementation of the project activity, during monitoring and the one specified by the manufacturer (nameplate data). If grid electricity is displaced, the emission factor is calculated as in **ACM0002**. If both captive power and grid electricity are displaced, the weighted average of the emission factors is calculated. The weightings should represent the shares over the **last 3 years** (in case of a new facility, the share of grid versus import power of the most likely baseline scenario should be taken). **Leakage** is not considered.

4. Conclusions

4.1 Lessons from the analysis of large-scale methodologies

The comparison of the 43 proposed energy efficiency methodologies showed that there are very general but also project-type-specific reasons for failure.

Most methodologies have been rejected because they did not comply with implicit quality standards for baseline and monitoring methodologies. First of all, a clear and reader friendly presentation of the methodology without gaps in data and argumentation has to be ensured. The methodology has to be prepared in a transparent and conservative manner. Transparency results from the design of the methodology, while conservativeness has to be demonstrated explicitly for assumptions and values. The methodology has to be laid out step-by-step in order to be applicable right away. It is further indispensable to include tools to select the baseline scenario and to prove additionality. Although not all approved methodologies contain a tool to select the baseline scenario, it is strongly recommended to provide one as the additionality tool does not cover this aspect. The project boundary has not always been explicitly defined in the approved methodologies. Nevertheless, it is necessary to specify the boundary regarding the gases, the physical limits and, if required, the system, as this constitutes the basis for the calculation of the emission reductions. Leakage should either be addressed or be explicitly excluded with justification. Data sources have to be specified, giving priority to high quality data with low inherent uncertainty. Equations illustrating the calculations should be provided and explained. Although it seems to be a safe path to use methodological settings from approved methodologies, they might not be appropriate under new circumstances.

Apart from these general shortcomings, difficulties exclusively related to energy efficiency methodologies could be identified:
Net improvements are difficult to calculate if **dynamics** have to be taken into account (e.g. the equipment, the level or the quality of production in the baseline or the project scenario may be subject to changes). Then, a simple before-after-comparison is not valid. This can pose problems if the calculations and the monitoring would need to be very complex. Regarding rebound effects due to improved service levels, project participants should basically not be punished for their contribution to sustainable development. However, too many CERs may be

issued when the increase in emissions due to the rebound effect is completely neglected. At this point, guidance from the Executive Board is needed. As efficiency does not improve continuously but in leaps when equipment is replaced, the remaining lifetime of the baseline equipment plays an important role for the correct estimation of emission reductions. If the crediting period is longer than the remaining lifetime, these dynamics have to be covered by the methodology. Energy efficiency methodologies can use sampling to monitor these dynamics. However, no guidance has been provided by the Executive Board on how to set the sampling period and to select representative units. As energy efficiency project activities may be implemented in many sectors, methodologies should be sufficiently differentiated to account for **specific (technical) circumstances** (e.g. regarding cement industry, electrical power systems, district heating, transportation and demand-side management).

In most cases a proposed approach has been rejected by the Executive Board because it was not sufficiently substantiated and justified. However, the final recommendations of the Meth Panel clearly state that the following settings are not valid:

- Approach 48c is used, but the average emissions of similar project activities are based on historical data only. (e.g. NM0003)
- The sample activities are not similar to the project activity regarding all key technological circumstances. (e.g. NM0003)
- A list of alternative scenarios is provided, but criteria to select the baseline scenario are not indicated. (e.g. NM0031)
- Hydroelectric sources are excluded from the OM because of their cost of generation (e.g. NM0031).
- Baseline emissions are claimed for renewable biomass residues. (e.g. NM0040)
- The common practice threshold for blended cement refers to the market for all kinds of cement and not to the relevant market. (e.g. NM0045)
- A black-box model is used. (e.g. NM0045)
- For a retrofit project activity, equivalence of service is assumed without appropriate justification. (e.g. NM0046)
- Renewable energy sources in the grid mix are excluded from the build margin based on the statement that renewables can never be displaced by fossil sources. (NM0070)
- Approved methodologies are not applied as specified. (e.g. NM0059)

- Fixed baseline emissions are used for a retrofit without taking into account possible changes in production. (e.g. NM0071)

4.2 Guidance from small-scale methodologies

Some of the conclusions drawn from the analysis of small-scale methodologies could already be confirmed. The two-step procedure of calculating the baseline emissions (the energy use times the emission factor) is in principle the underlying rationale, but savings can also be calculated directly. Emission factors for grid electricity are calculated following the procedures of approved large- and small-scale methodologies. Emission factors for fossil fuels can be developed out of regular measurements, reliable local/national data or laboratory tests. Otherwise IPCC default factors are used. In the case of AM0017, the DOE has to check the reliability of local values for the carbon content of the fuel used (which may be coal) and the application of the relevant IPCC value. The approach 48a) has been used for retrofits. For new equipment, approach 48b and c) would be appropriate; however, approach c) has never been used successfully. Although control groups have been used, this happened under approach 48a).

In contrast to small-scale methodologies, the remaining lifetime as well as the construction and use of samples have to be treated in large-scale methodologies. Regarding the approved methodologies for energy efficiency and fuel switching measures for industrial facilities, either the energy use of the whole facility is measured or the savings are directly calculated. Samples or estimates have not been applied to monitor the energy use.

As no approved methodologies are available for the transmission & distribution activities and demand-side programmes, definite conclusions cannot yet be drawn. The proposed transmission and distribution methodologies (district heating) have all been rejected. In most of these cases, the calculation of the baseline emissions is based on the emissions of the existing equipment (alternatively, the difference in fuel consumption), but also taking into account the use of substitutes by the households (e.g. consumption in individual heaters covering a demand gap) and anticipating changes in efficiency and equipment. T& D losses are either estimated or ignored. Regarding demand-side programmes, the weighted power average of the equipment on the market is used to model the baseline emissions. Adjustments e.g. for possible efficiency improvements are made. Manufacturer's data and

samples (e.g. yearly surveys) are used to meter energy use or power and operating hours.

Efficiency measures in agriculture have not yet been addressed by large-scale methodologies.

5. References

IEA (2005): "The biggest fuel", International Energy Agency (IEA), SB22, Side Event, Bonn, 20 May 2005

Michaelowa, Axel; Stronzik, Marcus; Eckermann, Frauke; Hunt, Alistair (2003): Transaction costs of the Kyoto Mechanisms, in: Climate Policy, 3, 3, p. 261-278

Primary data related to baseline and monitoring methodologies submitted by the project participants to the Executive Board (i.e. Project Design Documents, Public Comments, Responses to preliminary feedback by the Project Participants, Final Recommendations by the Meth Panel), http://cdm.unfccc.int/methodologies/PAmethodologies, (2005-08-03)

UNFCCC (2005): Indicative baseline and monitoring methodologies for selected small-scale CDM project activity categories, Appendix B1 of the simplified modalities and procedures for small-scale CDM project activities, http://cdm.unfccc.int/Projects/pac/ssclistmeth.pdf, Bonn

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