Towards a more standardised approach to baselines and additionality under the CDM

Determining nationally appropriate performance standards and default factors

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Executive summary

The Clean Development Mechanism (CDM) has been a success in both the number of projects and the amount of emission reductions it has mobilised. On the other hand, an increasing number of stakeholders are calling for a reform of the CDM for further improvement of the mechanism. Of particular concern is the cumbersome procedure of baseline setting and additionality testing. The baseline defines the emission level that would have existed under a business-as-usual (BAU) scenario, while a project is additional if it would not have happened in the absence of the revenue from sales of Certified Emission Reductions (CERs). In order to operationalise these concepts, complex methodologies and procedures have been introduced to the CDM.

CDM methodologies often have very narrow applicability conditions and require cumbersome data collection. Also, the bottom-up methodology development process requires significant time and effort from project developers, and does not necessarily provide developers with incentives to develop widely applicable methodologies. The additionality testing approach – especially barrier analysis – is not objective enough. There is a lack of clarity and guidance on additionality testing, leading to inconsistent application of the test among project developers. In order to facilitate project development, to increase the environmental integrity of the CDM and reduce inconsistency of decisions on project registration, a greater use of performance standards has been proposed. This builds upon a trend to introduce elements of standardised approaches in approved CDM baseline methodologies and should help to further standardise the current complex and often subjective process of baseline setting and additionality testing. **Standardised approaches could address many of the criticisms levelled at the CDM** but they also need careful implementation and regulatory oversight in order to ensure the environmental integrity of the CDM is maintained.

Standardised approaches rely on a performance standard approach, which consists of the "comparison of performance against peers based on a set of criteria". **Performance standards can be used either for baseline determination, or additionality determination, or both.** Baseline emissions could be derived from a set of similar installations. Project additionality would be deemed to exist if a level derived from a set of similar installations is beaten. The development of standardised approaches is divided into two broad processes. Firstly, it has to be decided which performance indicators will be used to determine the performance standard. Secondly, the threshold level for the selected indicators has to be decided, which specifies the baseline and/or the level that has to be beaten to show additionality of a project.

Performance standards have already been widely used throughout the world for comparison of energy and/or emission performance of companies. The key technical aspects crucial to the success of performance standards are: **(1) level of aggregation, (2) data requirements, (3) stringency of the performance standard, and (4) updating of the performance standard.** The experience gained with the initiatives worldwide for the use of standardised approaches shows some convergence in the approach to defining performance standards. First, performance standards are commonly set on a product or service-specific basis. Second, separate performance standards are usually set for new and existing installations. On the other hand, there are key disagreements in the treatment of technological differences and the choice of stringency level of performance standards.

Although highly standardised approaches exist in a few sectors (e.g., aluminium and cement), the approaches taken in other sectors are very diverse and thus require further harmonisation. US initiatives try to standardise additionality demonstration, and in some cases baseline setting, with the use of performance standards. The performance standards are defined either by **an emission rate, specifications on technology or practice, or a market penetration rate.** However, the reliability of this approach has not yet been evaluated independently.

Performance standards have also been used in CDM methodologies, though only on a relatively limited scale. The existing methodologies based on performance standards have focused on sectors where a large body of data is already available (e.g., power, aluminium, cement sector). **Detailed disaggregation by product type is not common.** On the other hand, nearly half of the methodologies using standardised approaches differentiate performance standards by technology or fuel type. **The temporal threshold is commonly set as "most recent five years". The spatial boundary is normally the host country or the power grid.** Further expansion of the boundary is required if there are insufficient peers for comparison within the boundary. A few methodologies allow for the use of conservative default factors. **The stringency of performance standards is typically set as the average of the top 20% of performers**. This threshold stems from the Marrakech Accords, and detailed technical judgements on the "right" level of performance standard stringency have not been made yet. **Performance standards are normally updated only at the renewal of a crediting period, i.e., every seven years.** Only a few methodologies require annual updating. Where this is required, a default value for the performance standards adjustment is provided in most cases. In terms of additionality testing, approaches similar to the US approach to performance standards exist in approved CDM methodologies. Furthermore, one CDM methodology uses an emission-rate based performance standard explicitly for additionality demonstration.

Developing standardised approaches can be complex and approaches need to be specific to each sector. However, experience has shown that this complexity can be mastered. In general, sectors appropriate for standardised approaches produce outputs or services similar in their nature and in their production processes. Also, ideal sectors are highly concentrated, with limited geographical factors affecting the level of greenhouse gas (GHG) performance, and already have a large amount of data available for the design of performance standards. Therefore, **standardised approaches are likely to be a suitable instrument for large, homogeneous sectors.** For sectors less amenable to standardised approaches, alternative approaches (e.g., default parameters) have to be considered as a fall-back option.

An appropriate level of aggregation plays a crucial role in filtering out projects with characteristics which are not representative of the baseline. An important trade-off exists between the simplicity and the stronger investment incentives for low-carbon technologies given by a single performance standard, and the opportunities for performance improvement by high-carbon technologies provided by performance indicators differentiated by technology. One of the most important grounds for disaggregation is the differentiation between new and existing installation projects. Other important parameters for disaggregation are product homogeneity and the geographic availability of certain resources to supply the target market. As well, local conditions can have a large influence on additionality.

Setting the right level of stringency for baseline and additionality is essential. **The choice of the stringency levels has to ensure a balance between credited emission reductions by the standardised approach and real emission reductions generated.** The more stringent a performance standard is, the more likely that non-additional projects are weeded out, but at the same time less projects will be able to beat the performance standard. The determination of specific levels for additionality and baseline should rely on expert judgement and should be based on in-depth technical and economic understanding of the specific sector and efficiency or carbon intensity distribution curves of BAU projects. A large body of objective data that can inform the decision is available, such as knowledge of BAU practices and technology costs. Where the judgement cannot be made with sufficient rigour, project-specific additionality tests or credit discounting should be used as an alternative approach.

As performance of a sector changes over time due to autonomous technical progress and other factors, performance standards need to be updated regularly. This is especially important for existing installation projects, which are more likely to see autonomous technological progress over time, including both technical and operational measures. For new installations, most of the measures are expected to be implementation of specific technologies, and they would in most cases last until the end of the crediting period. In this case, the baseline level should be fixed for the crediting period applicable to the project, or only be updated according to parameters which can be improved without major technical upgrades.

Standardised approaches are feasible with careful design. However, **this will require an improvement in data collection, and the early set up of adequate institutions, as well as the development of specific approaches.** Data collection efforts which could be used by the CDM are already underway, but need to be scaled up. New data collection should be started as soon as possible for additional key sectors. Additional data (e.g., on mitigation costs and current practices) might be needed in order to derive appropriate levels. The overall timeframe for the development and approval of standardised approaches would be between one and four years (including data collection), depending on the complexity of the sector and the availability of necessary resources for standardised approaches. A preliminary cost estimate of the development of a standardised approach covering 200 plants would be €1.2-4.5 million, assuming one-year monitoring for the data collection. If the data already exist, the cost would be €0.2-0.5 million. In particular, data collection is the most time and resource-consuming step and would require substantial international upfront financing. The overall cost-effectiveness of standardised approaches is largely influenced by the number of performance standards to be established and the replicability of projects that the standardised approaches target.

The shift of the burden of developing baselines and demonstrating additionality from project developers to a dedicated body would likely **encourage greater participation of underrepresented countries, e.g., the least developed countries (LDCs) in the CDM.** However, installations in these countries are typically less efficient in emissions performance. If performance standards are set without taking into account the local conditions of these countries, standardised approaches would likely result in an unfair distribution. Moreover, many host countries currently lack the capability to set up appropriate performance standards. The capacity to monitor, report and verify emissions and activity data for the relevant sector and its installations needs to be developed and supported by financial and technical assistance. Given that the CDM only issues CERs ex post, there will be a financing gap between the establishment of the domestic institutional capacity and the revenues from potential CERs and thus both technical assistance and funding is required. Besides the possible financial support from the surplus of the CDM Executive Board (EB), multilateral or unilateral support programmes could be established to increase institutional feasibility.

If standardised approaches become a voluntary option, project developers would have a choice between a presumably stringent standardised baseline and a project-based baseline. This would provide positive incentives for exploring new CDM opportunities, potentially leading to an improved distribution of CDM projects. Mandatory standardised approaches could reduce the CER potential as performance standards are likely to be set more stringently than in BAU scenarios.

The case study on whole-building efficiency improvement projects shows that standardised approaches can provide solutions to some of the key barriers to building efficiency projects by allowing a **combination of mitigation measures,** giving **wider flexibility in technology choice,** and **streamlining monitoring requirements**. It is of note that, besides implementation of concrete technologies (hard measures), management measures that reduce emissions through operational improvement or behavioural changes are also an integral part of building efficiency improvement. Although the CDM has conventionally focused on hard measures, **standardised approaches need to work with soft measures** as impacts of any measures will be reflected in an emission performance indicator (in tCO_2/m^2) on which the approach needs to be based. A careful balance in the choice of aggregation level is crucial as standardised approaches to this project category require a relatively high degree of disaggregation. In order to be cost-effective, it is recommended that **initial efforts focus on homogeneous, energy-intensive building unit categories** (e.g., residential) **in regions with a high potential of replicability** (e.g., East Asia, South Asia, and Middle East & North Africa). International support is necessary in order to overcome the limited data availability and institutional capacity with which most host countries are faced.

The case study on charcoal production reveals that standardised approaches could help realise its large untapped mitigation potential, primarily by **streamlining the current complex monitoring requirements.** In Sub-Saharan Africa, where the largest mitigation potential through efficient charcoal production exists (ca. 100 $MtCO_2e$/yr), **the degree of disaggregation can be kept relatively low** due to the great homogeneity in charcoal production observed in the region. Also, the replicability of this project type is considered high. Thus, standardised approaches are **likely to prove cost effective**. Further, the impact on environmental effectiveness and geographical distribution would likely be positive. As further data collection efforts are needed, international support for capacity building and funding is essential. Most importantly, data collections on the share of non-renewable biomass should be improved.

In conclusion, we recommend the following:

- Set standardised approaches in a **product or service-specific** manner.
- **Recognise soft measures:** A performance standard set as emissions per output inherently accommodates impacts of any mitigation measure. Soft measures have been excluded from the CDM so far as they do not result in stable, long-term emission reductions. But standardised approaches need to work with soft measures.
- **Differentiate the standardised approach between new and existing installations**, and according to vintage classes so that sufficient incentives for improvement are given to existing installations.
- **Choose appropriate performance indicators:** Given the one-off decision on the indicators, it would likely be challenging to agree on indicators because there are many vested interests. Wrong decisions on performance standards are more difficult to reverse than wrong decisions on specific projects, as performance standards cannot be changed very frequently.
- **Balance the aggregation level of a standardised approach:** The aggregation level is a key determinant of the effectiveness of standardised approaches. Highly aggregated standardised approaches increase the risk of non-additional projects while not harnessing certain mitigation potentials, as they cannot capture country or even region-specific differences in project attractiveness. Low levels of aggregation raise issues of data confidentiality. The choice of aggregation level has a strong impact on transaction costs. In order to strike a balance, it is recommended that a standardised approach be

developed in a manner that is technology-neutral, but that distinguishes new and existing installations, possibly further differentiated by vintage classes.

- **Determine the right level of stringency for the performance standard:** An overly stringent performance standard for the demonstration of baseline and additionality will restrict uptake of the CDM in the target sector, while an overly lenient one could risk allowing large amounts of CERs from BAU projects. The decision on stringency levels therefore requires a high degree of judgement and will inevitably be contested. However, a large body of objective data is already available that can aid the decision on the stringency level.
- **Regularly update performance standards:** Due to technical progress over time, performance standards need to be updated at regular intervals. The length of the interval depends on the speed of technology development but is likely to be several years. Clear processes for updating performance standards should be defined upfront.
- **Set up a Standardised Approach Coordinator (SAC):** The SAC would function as a working group or panel reporting to the CDM Executive Board. Its functions would include calculating the performance standards for specific sectors or for specific countries, coordinating data collection and preparing standardised approaches for approval by the CDM EB.
- **Ensure transparency of decision-making:** It is essential that a transparent process for standardised approaches development be ensured, providing open access to the performance standard study results and opportunities to give public inputs at key milestones in the process.
- **Provide support for standardised approaches development:** Introduction of standardised approaches shifts costs from project developers to public institutions. A high share of the cost accrues upfront, but recurrent costs for updating of specific levels should not be underestimated. Performance standards cannot be developed without the collaboration of host country institutions in providing data, and international support for financing and technical assistance is indispensable. Seed funding could be taken from the accumulated surplus of the CDM EB that has reached about $40 million.

1. Introduction

The objectives of the CDM, as set out in the Kyoto Protocol, are twofold: (1) to assist developing countries (non-Annex I countries) to achieve sustainable development whilst at the same time (2) to assist developed countries (Annex I countries) in achieving compliance with their quantified emissions targets in a cost-effective manner (UNFCCC 1998). These targets are not necessarily consistent, as a focus on cost-effectiveness may lead to low sustainability benefits, while projects with high sustainability benefits may be more costly and thus less competitive (e.g., Sutter and Parreño 2007).

Does the CDM in its current form meet these possibly conflicting demands? Both the number of CDM projects and the expected CER volumes support a positive conclusion. On the other hand, an increasing number of stakeholders have called for a reform of the CDM for further improvement of the mechanism. The criticisms focus particularly on the cumbersome procedure of additionality testing, where both NGO and industry representatives argue that no objective measure of additionality exists (e.g., Hayashi 2007, IETA 2006). Given the increase in rejections of projects due to perceived lack of additionality and the increase of transaction costs for regulators and project developers alike, the burning question is whether an alternative to the current project-specific additionality test can be found.

This study assesses the potential of standardised approaches as a means to standardise procedures for CDM baseline setting and additionality demonstration. At the international climate negotiations, standardised approaches are referred to as standardised, multi-project baselines. A greater use of standardised approaches is being discussed under the Ad-hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP).

We first analyse the current status of the CDM in Ch. 2 to examine where standardised approaches could play an important role for the improvement of the mechanism. In Ch. 3, we then provide an overview of the existing standardised approaches available, both outside and within the CDM, to analyse implications of adopting a CDM based on standardised approaches. Ch. 5 further elaborates on the methodological approach for standardised approaches. In Ch. 5, practical issues related to the implementation of standardised approaches under the CDM are discussed in detail. Based on the above analyses, we assess implications of a greater use of standardised approaches under the CDM in Ch. 6. Furthermore, detailed case studies are presented for whole-building efficiency projects in Ch. 7 and charcoal production projects in Ch. 8. Finally, Ch. 9 concludes.

2. Current status of the CDM

– Summary –

The number of registered projects and their expected CER volume underlines the overall success of the CDM. Nevertheless, a closer examination of the mechanism reveals some deficiencies.

CDM projects are not distributed equally across countries, sectors, and project-size categories. For instance, the number of CDM projects in Africa lags far behind Latin America and is minuscule compared to Asia & Oceania. Some sectors or scopes are not as well represented as their mitigation potential would suggest - only few projects have been registered in sectors such as energy distribution, transport or construction. Besides the unequal geographical distribution of registered projects, it becomes obvious that the mechanism favours projects that surpass a certain volume of CERs per year, i.e., 20,000 CERs.

The contribution of the CDM to sustainable development has been questioned, as has its environmental integrity. The rules and procedures are seen as complex, partially inconsistent and unreliable, as they are frequently changed over time. These problems have generated criticisms of the CDM and a call for reform among various stakeholders.

Although it has improved gradually over time, the determination and assessment of additionality is still a contentious aspect of the CDM. **Further standardisation of methodologies is called for** in order to streamline the complex and often subjective process of baseline setting and additionality demonstration.

2.1 Mixed outcome of the mechanism

The overall numbers of the CDM with 1909 projects registered to date and the related volume of 1.68 billion CERs expected until the end of 2012 demonstrate the success of the mechanism (UNFCCC 2009a). However, a detailed examination of the figures discloses several discrepancies. Not all regions and not all sectors are integrated equally into the success of the mechanism. Furthermore, the size of a CDM project in terms of CER volumes has an important impact on its success.

2.1.1 Geographic distribution

The share of CDM projects in terms of number of projects and CER volumes shows the successful implementation of the mechanism in Asia and, to a certain extent, in Latin America. In contrast, Africa is clearly left behind (Figure 1).

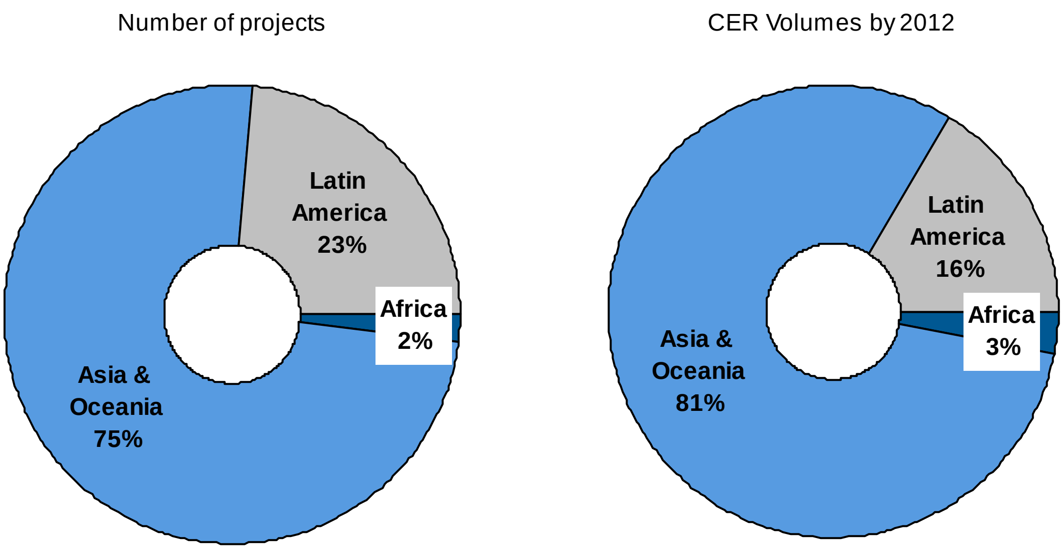

Figure 1: Regional share in number of registered CDM projects and their CER volumes by 2012

Status: November 2009, Source: Point Carbon (2009a)

However, it should be noted that Africa's share in the CDM is consistent with its share in global GDP and global GHG emissions. The trend in the number of African projects in the pipeline has been increasing recently. The Programme of Activities (PoA) mode, which was introduced in 2007 by the CDM Executive Board, set out the framework for more efficient implementation of CDM projects and could thus mobilise more projects in underrepresented countries, and improve the geographical distribution.

2.1.2 Sectoral distribution

Similarly to the unequal geographical distribution, the number of projects and related CER volumes are unbalanced among different sectors. It is obvious that the technical potential of GHG emission reductions has to date not been harnessed by the CDM in all sectors. Renewable energy and waste projects have greatly benefited from the CDM so far, in terms of both number of projects and CER volumes. Industrial processes projects (e.g., N_2O, HFC) also expect a large amount of CERs, though with a small number of projects. On the other hand, fuel switch and land use, land-use change and forestry (LULUCF) projects are significantly underrepresented. The energy efficiency category, in its aggregated form, shows a favourable result thanks to the good achievement of industrial energy efficiency projects. However, the CDM faces great barriers in mobilising efficiency improvements in energy distribution, energy demand, and transport (Figure 2).

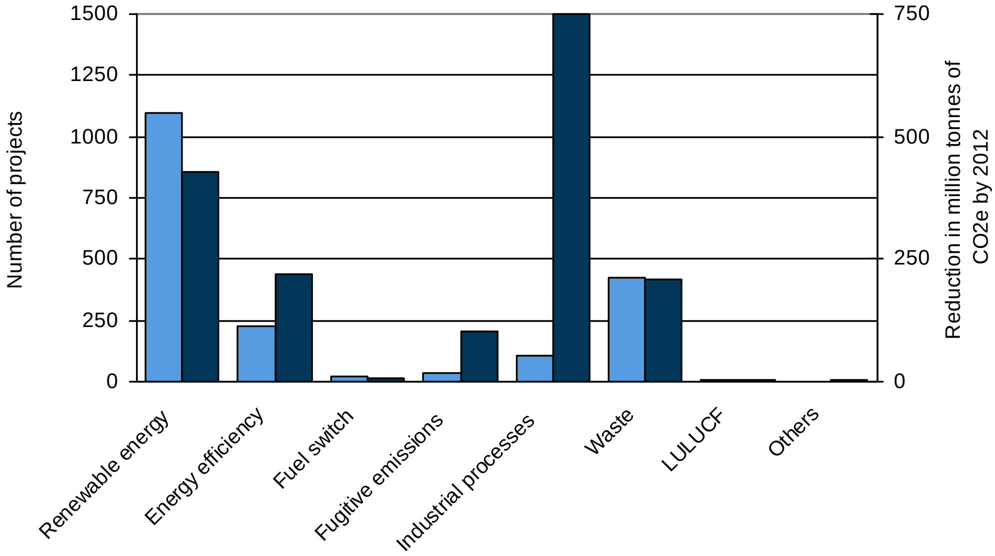

Figure 2: Number of registered CDM projects and their annual expected emission reductions by project type

Status: November 2009, Source: Point Carbon (2009a)

2.1.3 Project-size distribution

The CDM has been criticised for its high transaction costs due to its complex regulatory and technical requirements. Therefore, CDM projects with high CER generation potential are favoured by project developers. To alleviate the difficulties that small-scale projects would likely face due to high transaction costs, simplified rules and procedures were implemented at the start of the CDM operation. Nevertheless, the majority of the registered projects are found in the range of 20,000 to 100,000 CERs per year (Figure 3). In particular, micro-scale projects (less than 5,000 CERs per year) are significantly underrepresented. As explained above, by establishing rules and procedures for PoA, the regulators have paved a way for scaling up the potential of micro- and small-scale projects. An increasing number of PoAs is entering the CDM pipeline.

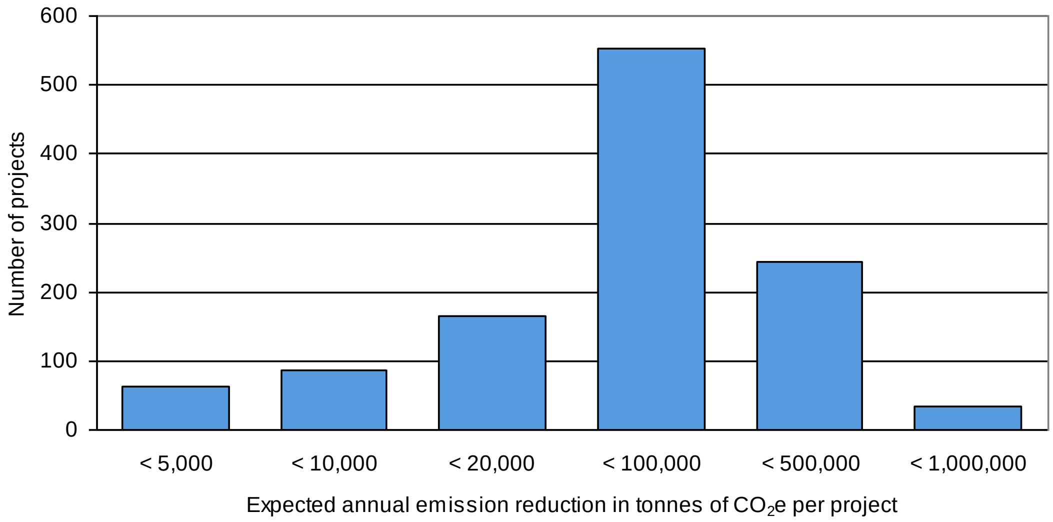

Figure 3: Number of registered CDM projects and their annual emission reductions by project size

Status: November 2009, Source: UNFCCC (2009a)

2.2 Criticisms and deficiencies of the mechanism

A number of stakeholders are currently calling for a reform of the CDM (e.g., CDM Watch 2009). The unbalanced regional, sectoral and project-size distribution is only one aspect of their critique. In addition they have questioned the mechanism's contribution to sustainable development in host countries and have criticised the rules and procedures of the CDM as cumbersome, inconsistent, and unpredictable. A serious concern also lies in the determination of additionality (Michaelowa et al. 2008).

Table 1: Main criticisms and deficiencies of the CDM

Subject	Deficiencies
CDM goals	**Sustainable development:** Sustainable development criteria are developed at national levels and thus undergo a "race to the bottom". Those criteria are often defined very vaguely and the host country approval has a "rubber-stamping" character. **Least-cost abatement:** Projects that manipulate baselines and additionality have negative abatement costs and thus generate no real and additional emission reductions.
Methodologies and additionality testing	**Methodologies:** Standardisation appears to be a complex task due to project-specific data requirements to calculate the baseline emissions. Applicability conditions are too narrow. Data source consistency

	is not guaranteed. Monitoring is very strict on some parameters whereas it is lax on others. **Additionality testing:** The current approach of additionality testing – especially the barrier test – is not objective enough. Also, there is a lack of clarity and guidance on additionality testing, leading to inconsistent application of the test among project developers.
Regulatory framework	**CDM design:** Project-based CDM activities have not contributed to rapid sector-wide transformations. **UNFCCC rule-setting bodies:** Lack of administrative capacity of the CDM body results in delays and requests for clarification. Multi-level nature of rules and rapid and frequent, sometimes inconsistent changes of rules makes it difficult to apply rules correctly. The EB is exposed to legal threats by project developers. **Designated Operational Entities (DOEs):** The quality of the validation and verification suffers from high competition on the market for DOEs and lack of training of their staff.
Project activities	**Geographical distribution:** Dominance of Asia & Oceania and Latin America whereas Sub-Saharan Africa and LDCs are left behind. **Project types:** Dominance of industrial gases projects, which provide no or very limited sustainable benefits to the host country.

Source: Adapted from Michaelowa et al. (2008)

While recognising the above deficiencies, it should also be noted that several of them are inherent in the very nature of the CDM. Without a rigorous regulatory oversight, the offset mechanism would increase the emission budget of Annex I countries to the Kyoto Protocol and jeopardise the environmental integrity of the system. Therefore, these criticisms have to be balanced against the mechanism’s natural setup and the benefits it has brought about.

A reform of the CDM is possible. In particular, the complexity and difficulties in the methodologies and additionality testing can be well addressed by standardised approaches. Standardised approaches could also enable rapid sector-wide transformations and improve the distribution of CDM projects.

2.2.1 Baseline and monitoring methodologies

The CDM is based on a huge body of rules within which a hierarchy applies. Its highest level is defined by international treaties that have been formally ratified by states, such as the Kyoto Protocol. The second level is agreed at the COP. The third level is a decision of the CDM EB. Advisory bodies to the EB shape important parts of rules even if they do not formally decide on them – as the CDM Methodologies Panel (MP) does with respect to proposed baseline methodologies. Depending on their hierarchical level, rules will have different characteristics and lifetimes (Michaelowa et al. 2007).

As stated above, the current CDM requires the application of methodologies to proposed projects in order to determine emission reductions that are real and additional. With 66 approved methodologies (AM), 16 approved consolidated methodologies (ACM) and 49 approved small-scale methodologies (AMS)[1], a large and complex regulatory system is currently in place. In addition, 15 methodologies are approved and active for afforestation and reforestation activities[2]. A general feature of the regulatory system for methodologies is the bottom-up approach requiring project developers to suggest new methodologies. Broekhoff (2007) argues that most methodologies have been designed around the specific projects being proposed by developers. He highlights the fact that developers prefer designing methodologies around project-specific factors to proposing standardised approaches. It is obvious that the development of standardised factors valid in various CDM host countries is beyond the capacity of individual project developers proposing new methodologies. Even if the capacity existed, a private company would not have an incentive to provide a public good to its competitors, as a methodology cannot be patented.

Besides the related costs, the required time and risk is an important aspect in the development of a new methodology. Generally, methodology development to the point of approval by the EB takes at least one year and the average rate of success has been only 40% so far (UNEP Risoe 2009). Considering that economically rational project developers will invest in the development of a new methodology only if they expect to implement a worthwhile number of CDM projects after approval of the new methodology, it is surprising that there are a significant number of methodologies that have not been utilised widely (Figure 4).

[1] Including only approved methodologies that are currently active.
[2] Including approved large scale, approved consolidated and approved small scale methodologies.

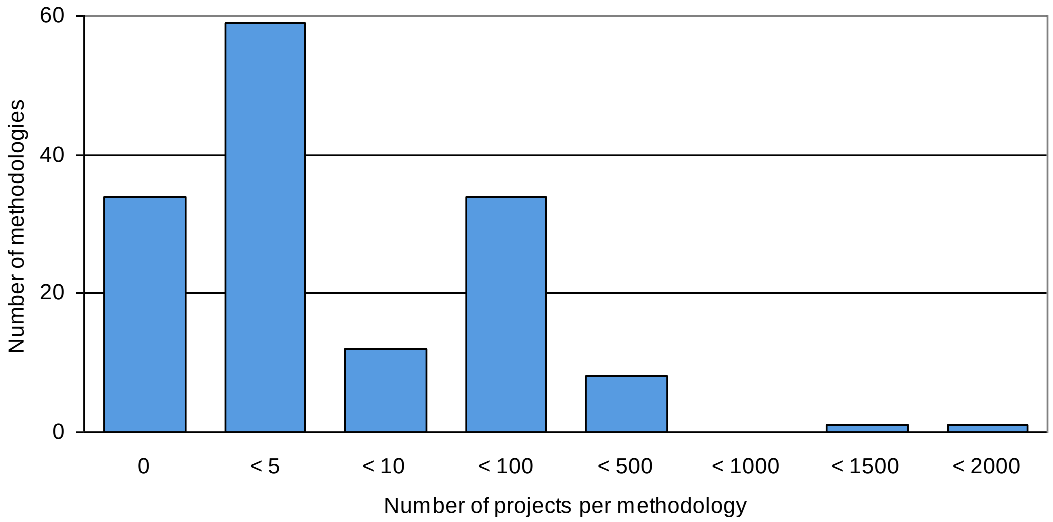

Figure 4: Number of projects per approved methodology (AM, ACM and AMS)

Note: The figure presents the number of projects registered, at the validation stage, rejected and withdrawn. More than 30 methodologies are not used at all. On the other hand, two methodologies (ACM0002[3] and AMS-I.D[4]) are applied to more than 1,000 projects.

Status: November 2009, Source: UNEP Risoe Centre (2009)

The main reason for the low use of an approved methodology may be that the methodology was changed substantially during the approval process and thus could no longer be used by the developer. Furthermore, the non-utilisation of certain methodologies implies that the rules and procedures in such methodologies are too laborious, conservative, and/or narrow in applicability condition. The United Nations Framework Convention on Climate Change (UNFCCC) has recently started examining the reasons for low utilisation of the methodologies and ways of improvement, as shown in its call for public inputs “Call for inputs on the reasons for no or low application of approved methodologies in CDM project” (UNFCCC 2009b). As a result, the EB has agreed to further streamline the procedures for consideration of new methodologies, request for revision and request for clarification. They have also decided to revise approved methodologies to further improve their objectivity, applicability, usability and consistency (UNFCCC 2009c). Furthermore, in order to facilitate the use of methodologies while safeguarding the environmental integrity of the CDM, they have agreed to continue developing conservative default parameters for use in baseline methodologies, as an alternative to setting project-specific parameters that are difficult to determine (UNFCCC 2009d).

[3] ACM0002: Consolidated baseline methodology for grid-connected electricity generation from renewable sources.
[4] AMS-I.D: Grid-connected renewable electricity generation.

2.2.2 Additionality testing

The additionality of a CDM project is a crucial factor in regard to the environmental integrity of CDM projects. CERs from non-additional projects undermine the emissions budget set for Annex I countries to the Kyoto Protocol. The essential idea underlying the concept of additionality is that the emissions reductions of a CDM project would not have happened under the BAU scenario. However, there are widely differing views about additionality. The interests of project developers and CER buyers are strongly aligned, as both sides want to maximise CER volumes. They argue that the concept of additionality does not make any sense, as it is impossible to gauge reasons why project developers invest in a project. Thus any project reducing emissions compared to a baseline should get CERs (e.g., Rentz 1998, IETA 2006). This transfers the determination of additionality into the baseline setting. For an economist observer this reasoning is a bit like that of a person who picks up a €20 bill lying on the sidewalk and then claims an extra payment from a bank for bringing this bill back into circulation. The other extreme is the demand made by environmental NGOs that no profitable project should be credited. Again, for the external observer, this position does not make sense either, as profitable projects may not materialise due to availability of more profitable alternatives, unavailability of capital, or other barriers. So the CDM should accept profitable projects as long as the project developer can show that these projects would not happen without the incentive from CER sales.

In order to ensure the environmental integrity of the CDM, the regulator has to introduce rigorous procedures for additionality determination. As it had become clear that agreement on a technical definition of additionality would not be achieved in a UNFCCC negotiating forum, the EB was left with the task – which it had the courage to achieve - of defining detailed rules for additionality through the “Tool for the demonstration and assessment of additionality” on a project-specific basis. While the tool is formally voluntary, it has become the de facto standard (see discussion in Michaelowa 2009). Depending on project scale and applied methodology, the additionality of a CDM project can be demonstrated by the following steps:

- Investment analysis
- Barrier analysis
- Common practice analysis

Developers can choose between the first two, but the last is mandatory[5]. Initially, the additionality analysis was often performed in a cursory manner.

The investment analysis can be conducted with a simple cost analysis[6], an investment comparison analysis[7], or a performance standard analysis[8] (for the share

[5] See the “Tool for the demonstration and assessment of additionality”. Available at: http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf.

[6] The simple cost analysis is applicable only if the project generates no financial or economic benefits other than CDM-related income. The project developer needs to demonstrate that there is at least one alternative which is less costly than the project.

of projects applying these options, see Figure 5). In applying the benchmark analysis, project developers have to evaluate an investment benchmark that is standard in the market, considering the specific characteristics of the project type. The determination of an appropriate benchmark is the task of the project developer. As a result, it is the project developer who has to cover the costs of data collection. Also, room is left for gaming with a "creative" interpretation of market figures, thus leading to registration of CDM projects with dubious additionality. The key problems are (1) the lack of transparency in calculation of a financial indicator, and (2) the subjective derivation of the financial benchmark value and sensitivity analysis range (Schneider 2007).

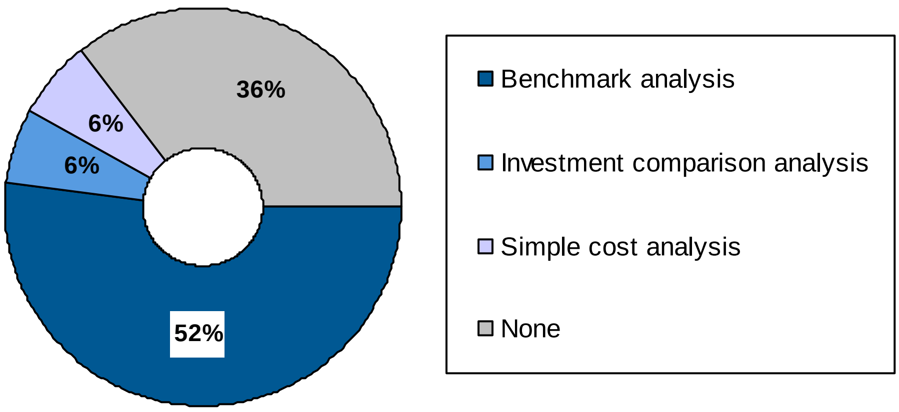

Figure 5: Share of CDM projects applying different approaches to the investment analysis for additionality demonstration

Status: November 2009, Source: IGES (2009)

Examples of barriers commonly used in the barrier analysis include financial risks[9], technology risks[10], and policy risks[11]. The crux of the barrier analysis is the evaluation of when a barrier is considered prohibitive. Schneider (2009) finds that "43% of the analysed projects applying the barrier analysis provide no explanation as to why the identified barriers would prevent the proposed project activity. If evidence for the barrier is provided at all, it is often internal company information that is difficult

[7] If the project generates financial or economic benefits other than CDM-related income, the investment comparison analysis has to be applied. The project needs to compare the investment options available to the project developer based on a common financial indicator, such as an internal rate of return (IRR), net present value (NPV), cost benefit ratio, or unit cost of service.

[8] As with the investment comparison analysis, the benchmark analysis is required if the project generates financial or economic benefits other than CDM-related income. The most suitable financial/economic indicator, such as IRR, is used for the analysis. A benchmark is derived from government bond rates, estimates of the cost of financing and required return on capital, a company internal benchmark, government/official approved benchmark, or any other indicators that are appropriately justified.

[9] E.g., a lack of capital or access to finance.

[10] E.g., a lack of capacity to manage the operation of the technology.

[11] E.g., a risk of future decrease of feed-in-tariff.

to assess objectively." Also, a project category is often too narrowly defined in applying the first-of-its-kind barriers[12], which makes the project seemingly first-of-its-kind.

The investment or barrier analysis is followed by the common practice analysis to confirm the results. The strength of the common practice analysis is that it does not assess the motivation or intent of project developers but provides a more objective approach to assess additionality. However, the main weakness of the analysis is that the current additionality tool does not clearly define when a project activity should be regarded as common practice. Similarly to the barrier analysis, another weakness of the common practice analysis is that the methodologies do not usually provide a clear definition of what a comparable technology is (Schneider 2007).

Over time, the regulator has gained more experience and provided more detailed rules on how these analyses are to be performed[13]:

- EB 39: Guidance on the assessment of investment analysis[14].
- EB 44: CDM validation and verification manual[15].
- EB 50: Guidelines for objective demonstration and assessment of barriers[16].

Nevertheless, due to the problems with project-specific additionality testing, both industry and NGOs are calling for further streamlining of the additionality demonstration procedure and argue that the current project-specific approach is inappropriate to ensure the overall environmental integrity of the CDM effectively and efficiently (CDM Watch 2009, IETA 2006). In an effort to further streamline the additionality testing procedure, the EB decided to provide more guidance on the use of the additionality tool, including the provision of the best practices for the barrier analysis, further guidance on the first-of-its-kind analysis, and details on the application of the investment and the common practice analyses (UNFCCC 2009d).

[12]First-of-its-kind barriers are the most commonly used barriers that show that the prevailing practice hinders the implementation of the project.
[13] Further information can be found at: http://cdm.unfccc.int/EB/index.html.
[14] Available at: http://cdm.unfccc.int/EB/039/eb39_repan35.pdf.
[15] Available at: http://cdm.unfccc.int/EB/044/eb44_repan03.pdf.
[16] Available at: http://cdm.unfccc.int/EB/050/eb50_repan13.pdf.

3. Standardised approaches to baselines and additionality

– Summary –

Standardised approaches have recently been used in some CDM methodologies. Outside the CDM, however, approaches based on performance comparison have already been used widely for energy and/or emission performance of companies. The approach requires careful consideration of the design of the following technical aspects: **(1) level of aggregation, (2) data requirements, (3) performance standard stringency**, and **(4) updating frequency**. The level of aggregation is further detailed in the following four dimensions: (a) process, (b) product, (c) time, and (d) space.

Performance assessment outside the CDM

A number of performance assessment initiatives already exist. **They typically set performance standards on a product or service-specific basis.** It is also common to provide differentiated treatment of new and existing installations. Further disaggregation of approaches by technology/process or product type is possible but increases the transaction costs. The European Union Emission Trading System (EU ETS) experience indicates that it is important not to disaggregate standardised approaches in too much detail.

In most cases, performance standards are established based on the empirical data obtained in recent years. The US offset programmes attempt to reduce the data requirements as much as possible by using default parameters. Such standardisation leads to improved usability of the methodologies but bears a risk of higher uncertainty in the emission reduction calculation. The Cement Sustainability Initiative (CSI) experience shows the importance of transparent data management by an independent third party.

Major discrepancies are observed in the choice of stringency levels of performance standards. Performance standards for existing installations are typically based on a percentile. However, the stringency level varies widely. The performance standard level for new installations is often referred to as the best available technology (BAT) and in some cases by the percentile approach. The BAT approach requires a clear definition of BAT.

The frequency of data and performance standard updating also varies among the initiatives. The CSI and International Aluminium Institute (IAI) data are updated every year. The EU ETS performance standards are updated only at the end of each trading period. The US Environmental Protection Agency (EPA)'s performance standards and standardised factors are updated every 5-8 years, depending on the project type.

The US initiatives try to standardise additionality demonstration, and in some cases baseline setting, with the use of performance standards. The performance standards are based on **a standard emission rate, specifications of technology or practice,** or **a market penetration rate**. However, the reliability of this approach has not yet been evaluated independently.

Standardised approaches under the CDM

Standardised approaches have also been used in CDM methodologies, though only on a relatively limited scale. The existing methodologies based on a standardised approach have focused on sectors where a large body of data is already available (e.g., power, aluminium, cement).

Under the CDM, **standardised approaches are also established on a product or service-specific basis.** Detailed disaggregation by product type is not common. On the other hand, nearly half of the methodologies based on a standardised approach differentiate performance standards by technology or fuel type. The temporal threshold is commonly set as "most recent five years". The spatial boundary is normally the host country or the power grid. Further expansion of the boundary is required if the number of peers is insufficient for comparison within the boundary.

In most cases, **performance standards are established based on empirical data from the most recent years.** No projection-based data is used in the existing performance standard methodologies. A few methodologies allow for the use of conservative default factors.

The performance standard stringency is typically set as the average of the top 20% performers. This threshold stems from the Marrakech Accords, and detailed technical judgements on the "right" level of performance stringency have not been developed yet.

Performance standards are normally updated only at the renewal of a crediting period, i.e., every seven years. Only a few methodologies require annual updating. Where annual updating is required, a default value for the performance standard adjustment is provided in most cases.

In terms of additionality testing, approaches similar to the US performance standards exist in approved CDM methodologies. Furthermore, a performance standard has also been used explicitly for additionality demonstration, yet on a very limited scale. Generally, we argue that **a single performance standard should be used for the baseline setting and additionality testing of new installation projects,** as a single performance standard can well represent the baseline of a sector and it entails a smaller risk of free riding. On the other hand, **separate performance standards should be set for the baseline setting and additionality testing of the existing installation projects** in order to provide sufficient incentives for improvement, by setting a moderately stringent baseline while ensuring environmental integrity by a stringent enough standardised additionality level.

3.1 The concept of performance comparison

The standardised approach is based upon a "comparison of performance against peers based on a set of criteria". A comparison against peers implies that entities have a common output which makes them comparable to each other (e.g., electricity generation, cement production, etc.). Greater use of standardised approaches is proposed as an option for improving the efficiency of the CDM, by standardising the baseline setting and additionality demonstration procedures (Michaelowa et al. 2008). The key concepts of standardised approaches are discussed below.

3.1.1 Use of performance standards

Performance standards can be applied at almost any level of a production or consumption process. The major functional levels of performance standards are listed below (from an upstream to downstream process):

- **Energy consumption in extraction and processing of fuels or raw materials:** This type of performance comparison analyses the energy efficiency of extraction and processing of fuels or raw materials (e.g., natural gas extraction and processing).
- **Supply-side energy conversion and/or fuel mix:** This type of performance comparison assesses the efficiency and/or carbon-intensity of the energy conversion process at a supply level (e.g., power production from natural gas).
- **Energy transmission and distribution:** This type of performance comparison evaluates the efficiency of energy transmission and distribution (e.g., transmission and distribution of grid power).
- **Demand-side energy conversion and/or fuel mix:** This type of performance comparison assesses the efficiency and/or carbon-intensity of the energy conversion to final energy at a demand level (e.g., supply of heating/cooling to buildings).
- **Final consumption of products or services:** This type of performance comparison is to evaluate efficiency in utilising products or services (e.g., heating/cooling of building floor).

Given the wide range of applications of standardised approaches, it is important to decide first what needs performance comparison. The above options are not mutually exclusive, and they can be used in combination.

3.1.2 Metrics for performance standards

Key Performance Indicators (KPIs) are commonly used in the field of climate change to express the climate impact of a certain activity (product or service) per unit of the function provided by this activity (e.g., the production of certain goods or services). The performance related to climate change can be defined according to the following formula:

$$\text{Performance} = \frac{\text{Impact}}{\text{Function}}$$

The performance can be compared numerically against peers in an easy way by using KPIs. Expressing a KPI requires the following:

- A numerator which is an indicator for evaluating climate impacts.
- A denominator which refers to the functional category of the output provided.

Depending on the choice of performance indicator, the numerator can express the following:

- Emissions level, direct and/or indirect (e.g., CO_2 emissions).
- Energy consumption level (e.g., kWh of electricity).
- Consumption level of a GHG-containing product or service (e.g., tonne of steel used for building construction).
- Penetration level of a certain technology or process (e.g., share of compact fluorescent lamps in residential lighting).

Denominators refer to the type of either product or service assessed by the performance indicator:

- Product (e.g., production of cement, steel, power).
- Service (e.g., air-conditioned floor space, person-kilometre driven).

The choice of KPI has a crucial impact on the applicability of the standardised approach and thus has to be made very carefully.

3.1.3 Implementation of metrics for performance standards

The following dimensions explain the fundamental technical aspects that are critical to the effectiveness of the implementation of performance standards metrics, i.e., KPIs (adapted from Lazarus et al. 2000, Broekhoff 2007):

- **Aggregation level:** The grouping of various types of potential projects into a single category with a corresponding single baseline is the defining aspect of performance standards. Four key dimensions of aggregation are: (1) process, (2) product, (3) time, and (4) space. First, the process dimension asks whether performance standards are differentiated by technology or process. Second, the product dimension analyses whether the product or service for performance comparison should be further disaggregated (e.g., primary/secondary aluminium as opposed to aluminium in general). Third, the temporal dimension assesses the age or vintage of peers for comparison. Lastly, the spatial dimension determines the geographical boundary in which the peers are located.
- **Data requirements:** The data obtained from a cohort of peers for performance comparison could be either empirical or projection-based. If empirical data is used, a performance standard is considered backward looking in that it is based on the actual emission performance of peers in the past. On the other hand, a performance standard can also be forward looking if some elements of projection are applied to the data used.
- **Stringency:** A key challenge with standardised approaches is striking a balance between over-crediting and under-crediting of mitigation efforts. Namely, performance standards have to be set at a level that ensures a

reasonable degree of environmental integrity while providing project developers with sufficient incentives for investment.

- **Updating frequency:** performance standards need to be updated periodically to reflect changing economic, social, technological, and environmental circumstances. Key issues are the frequency of and procedures for updating. Performance standards can be updated by recollecting the data from the peers, or based on a pre-defined autonomous improvement factor in emission performance.

3.2 Overview of existing performance comparison initiatives

To date, many industries have gained experience with performance comparison. However, performance comparison is mainly used as a management tool for identifying potential for improvement in operation (Neelis et al. 2009). In this section, we discuss selected performance comparison initiatives in which performance standards are used for international comparisons of GHG performance. Also, we analyse standardised approaches employed in key offset programmes in the US, where performance standards gained increasing support for standardisation of approaches to baseline and additionality determination.

3.2.1 EU ETS

The EU ETS is the largest multi-country, multi-sector GHG emission trading scheme worldwide. In January 2005, the system commenced phase I (2005-2007) of its operation, and it is currently in phase II (2007-2012). The eight-year phase III (2013-2020) will follow and play a central role in the achievement of the EU's climate and energy targets for 2020. The system covers the 27 EU Member States, plus the EU's neighbours Iceland, Liechtenstein and Norway. In terms of industry sectors, the EU ETS currently covers some 11,000 heavy energy-consuming installations in power generation and manufacturing. From 2012, it will be expanded to include emissions from flights to and from European airports (EC 2009).

Grandfathering based on historical emissions data has been the main approach used to distribute free allowances (EUAs) to individual installations in the EU ETS in phase I and II. However, performance standards were also used. In phase I, a majority of Member States used performance standards for initial allocation of allowances to new entrants. Only a few Member States used performance standards for existing installations. In phase II, performance standards have been a common methodological choice for new entrants, but they have also been widely used for existing installations or special cases (e.g., recently built plants with insufficient data) (Neelis et al. 2009).

A wide variety of standardised approaches have been used in phase II, which clearly shows a lack of harmonisation. The approach has yet to be harmonised among the

Member States for phase III. The key findings on standardised approaches are summarised below (for further details, see Annex I of this report):

- In principle, **performance standards are established on a product-specific basis**, expressed in tCO_2e/mass or volume output. This requires unambiguous and justifiable product classifications (Neelis et al. 2009).
- **Most Member States differentiate the stringency level for new and existing installations.** However, they do not specify stringency levels of performance standards, but just refer to the qualitative term, "Best Available Technology" (BAT). Only in a few cases is there explicit reference to Best Available Techniques reference documents (BRef) developed under the Integrated Pollution Prevention & Control (IPPC) directive to establish performance standards values (EC JRC various years). A percentile approach, referring to the top 10^{th} percentile of similar installations either globally or nationally, was also used by a few Member States.
- **Performance standards are established either irrespective of the technology used** (e.g., one performance standard for cement), or they are differentiated by technology or fuel type (e.g., differentiated performance standards for different kiln types in the cement sector). Neelis et al. (2009) argue that performance standards should provide incentives for companies to select the most cost-effective emission reduction options available, and such incentives are weakened if the performance standard is disaggregated too much in detail (e.g., multiple performance standards for one product).
- The activity level, or production level, has been determined in different ways. For new entrants, the activity level was determined by a combination of plant capacity and a standard utilisation factor, by plant capacity only, or based on a forecast. As to existing installations, either historical productions or a forecast was used.

Though the EU ETS experience with the design of standardised approaches based on performance standards is large, it needs significant harmonisation of the diverse set of methodological approaches. Also important is transparent documentation of the methodological formulas and data used for standardised approaches. Only a limited amount of performance comparison data has been made publicly available (except for the UK).

3.2.2 Cement Sustainability Initiative

The Cement Sustainability Initiative (CSI) was initiated in 1999 by 10 leading companies operating in more than 80 countries. Since 2003, cement companies have been reporting their CO_2 emissions using the Cement CO_2 Protocol, developed by the CSI together with the World Resources Institute (WRI). The results of the performance comparison are updated annually. Most of the largest cement producers worldwide are members of the CSI, except for China, where coverage is scanty. Together, the 19 members of the CSI represent around 60% of worldwide cement production outside of China. In the EU, North America and Latin America, this coverage is close to 70% or higher (Mages 2009) [17].

One of the first efforts of the CSI has been to create a unified and comprehensible protocol to monitor and calculate CO_2 emissions from the cement sector on a plant-by-plant basis. This tool, called the "CO_2 emissions inventory protocol", is widely used across the whole cement industry, even beyond the CSI membership. Based on the values reported in the protocol, the CSI developed 19 key indicators as part of the "Getting the Numbers Right" (GNR) programme (Vanderborght 2007). The stated goal of the GNR programme is to enable comparisons in energy and GHG intensity of plants for clinker and cement production worldwide and regionally. Out of over 3,000 cement plants operating on a meaningful scale worldwide, the GNR system presently covers 845 plants, with almost half of them in developing countries (Mages 2009). As an open system, it is expanding to non-CSI members, especially in non-Annex I countries.

The standardised approach takes so-called "cementitious product" as a denominator of the performance standard. Cementitious product is a generic term used to designate the whole range of products supplied to be used for their cementitious (cement-like) properties (cement, but also other products like blast furnace slag or pulverised fly ash used by the ready-mix concrete industry) (WBCSD 2008a). The use of cementitious product as the denominator ensures a comprehensive coverage of emissions from the cement sector. The CSI retained PricewaterhouseCoopers (PwC) to design and manage independently the performance data system to ensure accuracy of the information and adequate safeguards to protect confidential business information (WBCSD 2008a). The data can be released only upon approval by the CSI secretariat. However, in principle, the data can be requested by anyone, even outside the CSI membership (e.g., several requests by non-CSI members have been approved in the past) (Mages 2009). Between 1990 and 2006, CSI members reduced their average CO_2 emissions intensity by 12%, from 752 to 661 $kgCO_2/t$ cementitious (WBCSD 2008a).

The key challenge for the CSI standardised approach is **the limited coverage of cement production in certain regions**, especially in India & China and Community of Independent States (CIS). In addition, data is currently missing on plant-specific conditions (e.g., detailed production process and technology). This would limit the possibility of further disaggregating standardised approaches, if further disaggregation were required.

[17] The CSI member companies represent a major share in cement production in the EU (93%), North America (78%), and Latin America (67%). Other regions with a good coverage include Asia (excl. Japan, India & China and CIS) (42%), Japan, Australia & New Zealand (41%), and Africa & the Middle East (37%). The membership in CIS (14%), India & China (9%) is limited (Mages 2009).

3.2.3 International Aluminium Institute

The production of primary aluminium leads to the direct and indirect emission of various GHGs. The indirect CO_2 emissions from the aluminium industry are mainly the result of consumed electricity. Across technologies, direct emissions of perfluorocarbons (PFCs) contribute on average roughly one-third of direct GHG emissions in the aluminium production process, while CO_2 emissions contribute to the remaining two-thirds of direct GHG emissions (Marks 2007).

Regarding the monitoring and reporting of GHG in the aluminium industry, there is a standardised protocol developed by the WRI and the World Business Council for Sustainable Development (WBCSD), which was amended by the IAI (IAI 2006). The protocol is widely used, especially to quantify the results of PFC emission reductions, to which the industry committed itself through voluntary agreements (IAI 2008). Moreover, as a result of their efforts to improve energy efficiency, the aluminium industry also uses the protocol to compare plants to the worldwide BAT (Porteous 2007).

Based on the data collected from IAI members, accounting for over 60% of the primary aluminium production worldwide, performance standards are established for one tonne of aluminium production for both direct (i.e., PFC) and indirect (i.e., CO_2 from electricity use) emissions from the aluminium production process. **The performance standards are differentiated by aluminium smelting technology type.** Between 1990 and 2006, the members of the IAI managed to reduce global PFC emissions by over 30%, while the primary aluminium production increased by 80%. In the same period, they have also reduced specific electricity consumption for aluminium production by 6% (Chase 2008). The results of the performance comparison have been updated every year since 2004.

The key strength of the IAI performance assessment is its higher degree of process disaggregation; the performance standards have already been established for each major smelter technology. Areas for further improvement include survey participation, especially in China and Russia. The coverage of the survey of PFC emissions in 2003 was 61% of global aluminium production (IAI 2005).

3.2.4 California Climate Action Registry

The California Climate Action Registry (CCAR), launched in 2001, is a voluntary GHG registry designed to allow companies and organisations operating in California to inventory and report their GHG emissions. The number of members totals 344 as of July 2009. Under CCAR, a national offset programme, Climate Action Reserve (CAR) was established to help ensure that the US carbon market provides rigorously quantified environmental benefits while upholding integrity and financial value (CAR 2009a). CAR has approved offset methodologies for the following project categories:

- Coal mine methane (CH_4)
- Landfill
- Livestock
- Organic waste digestion
- Forestry
- Urban forestry

The CAR offset methodologies set a predefined baseline scenario, so project developers do not have to analyse what the most likely baseline scenario will be. On the other hand, most of the categories include significant project-specific elements in their baseline emission calculation procedures.

The CAR methodologies use an explicit standardised approach to determining additionality, based on “legal requirement tests” and “performance standards”. The legal requirement tests confirm that the emission reductions achieved by a project would not otherwise have occurred due to any legally binding mandates. The performance standards are largely based on either (1) a technology standard, or (2) a practice standard. These standards may be revised during the process of methodology revision, which takes place on an irregular basis.

Technology standard: For instance, a livestock project is automatically deemed additional if it installs an anaerobic digester for the control of CH_4 emissions from dairy and swine livestock[18].

Furthermore, a landfill project is considered additional if a new qualifying CH_4 destruction device is installed at an eligible landfill where landfill gas has never been collected and destroyed, or where landfill gas was collected and destroyed before the project start using a non-qualifying CH_4 destruction device (e.g., passive flare). Qualifying destruction devices are a utility flare, enclosed flare, engine, boiler, pipeline, vehicle, or fuel cell which can serve as the primary destruction device for a CH_4 destruction project[19].

Practice standard: For instance, an organic waste digestion project passes the performance standard test if the project digests feedstock that is highly likely to result in CH_4 emissions under common practice management practice. Namely, the project should digest one or more of the following eligible organic waste streams consistently, periodically or seasonally: municipal solid waste, food waste, and/or agro-industrial wastewater[20].

[18] CAR’s rationale behind this is that the use of an anaerobic digester is very rare in the US. Even in California, which represents the US common practice in terms of the level of digester use and the likelihood of its use, digesters are found on less than 1% of the dairies. Hence, it concludes that the use of an anaerobic digester is beyond common practice (CAR 2009b).

[19] CAR apparently considers the installation of a qualifying CH_4 destruction device as additional based on their estimation that only 9.5% of unregulated landfills in the US have implemented voluntary landfill gas projects (CAR 2009c).

[20] CAR analysed three categories of organic wastes: solid food waste, agricultural solid waste, and agro-industrial wastewater. It then examined how waste emissions arise, the CH_4

3.2.5 US EPA Climate Leaders Programme

The Climate Leaders Programme is a voluntary industry-government partnership of the US EPA initiated in 2002. It aims to help companies develop long-term mitigation strategies by setting corporate-wide GHG emission reduction goals over five to 10 years, and annually reporting their progress to the EPA. The number of partners reached 284 in 2009, of which 127 have publicly announced their emission reduction goals (US EPA 2009a). Though an important objective of the programme is to focus corporate attention on achieving cost-effective emission reduction through internal projects, the partners are also allowed to use offset credits to help them achieve their goals (US EPA 2009b). There are currently seven project types eligible for offsetting:

- Captured CH_4 end use[21]
- Commercial boiler
- Industrial boiler
- Landfill CH_4
- Manure management: Anaerobic digester
- Reforestation/Afforestation
- Transit bus efficiency

The EPA has deliberately attempted to apply a top-down “performance standard” methodology to address additionality and selection and setting of the baseline for specific project types. The current project categories were selected largely based on their suitability for applying performance standards (Broekhoff 2007). The baselines of new installation projects[22] are determined by a standard rate reflecting a level of performance that is significantly better than average compared with recently undertaken practices or activities in a relevant geographic area. The performance level is presented in the form of (1) an emissions rate, (2) a technology standard, or (3) a practice standard, each of which is applied for a different set of technologies. Only the first of these is a real performance standard, whereas the latter have the character of positive lists. New installation projects apply performance standards for the baseline setting. The baselines of existing installation projects[23] are set by historical emissions levels except that the commercial and industrial boiler categories apply emissions rate standards for existing installation projects too.

The Climate Leaders Programme’s additionality determination approach is also based on performance standards. Namely, if a project reduces emissions beyond the pre-defined thresholds, the project is deemed additional. It is argued that the performance standard approach minimises the risk of accepting a project that is not

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potential of the waste, how it is managed in a BAU setting, and alternative management technologies (CAR 2009d).

[21] This is basically CH_4 recovery and utilisation at landfills or manure management systems.

[22] In this report, we use the term “new installation projects” for greenfield or scheduled replacement projects.

[23] In this report, we use the term “existing installation projects” for retrofit or brownfield capacity expansion projects.

additional or rejecting a project that is additional. Also, it reduces the complexity, cost, and subjectivity of constructing individual project-specific reviews (US EPA 2009b). The EPA plans to update the performance standards on a periodic (5-8 year) basis depending on the specific project type (US EPA 2009a).

Emissions rate standard: The commercial boiler, transit bus efficiency, and captured CH_4 end use categories are based on emission rate performance standards. The commercial boiler category applies the emission rate of the top 20th percentile of the commercial boilers installed since 1990 in the US. The transit bus efficiency category applies the emission rate of the top 10th percentile of US transit bus fleets in 2002[24]. A captured CH_4 end use project is considered additional if the end use component of the project does not substitute for a renewable (zero-emissions) fuel source. Namely, its performance threshold is based on the emissions rate from the type of fuel or energy input that will be avoided by the project.

Technology standard: For an industrial boiler project to be deemed additional, the project developer would have to add at least one of the technologies deemed beyond-average-standard by the EPA. These include (inter alia) non-condensing economisers, advanced burner and controls, and combustion pre-heater technologies.

Practice standard: A project in the landfill CH_4 or the manure management categories is deemed additional if the project technology is not currently installed and the installation is not required by law[25]. As for the former category, even if the landfill is currently collecting and combusting a minimal amount of landfill gas, a project can be additional upon satisfaction of the following two conditions. First, only the landfill gas combusted beyond the existing level is considered additional. Second, the project must either be designed to be entirely separate from the existing collection system or must be monitored separately from the existing system.

The reforestation/afforestation category requires a comparison of the management practice for cropland or pasture with the practice employed by other relevant entities. An automatic tool is available for calculation of the mean rate of land use transition from cropland or pasture to forest for the region of interest. The project is additional if the transition rate of the project surpasses the one of the baseline.

[24] For newly introduced bus fleets, the emission rate standard sets the baseline level too. For projects involving an engine conversion or early retirement and replacement of existing vehicles with more efficient buses, the baseline is equal to the annual emissions of the existing buses.

[25] This is risky for additionality determination, as it automatically assumes that these technologies are additional, without looking at their actual performance compared to peers.

3.2.6 Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI) is a regional GHG cap-and-trade programme covering 10 Northeast and Mid-Atlantic states in the US to limit GHG emissions from the power plants operating in these states. The programme started its first three-year compliance period in January 2009. CO_2 offset allowances may be used to satisfy a limited fraction of a source's compliance obligation. Each power plant covered by the programme will initially be allowed to cover up to 3.3 percent of its emissions using offsets, which may be expanded to 5% and 10% if a stage one or stage two trigger price of the CO_2 allowance is reached[26]. The following five project categories are eligible to generate offsets:

- Landfill CH_4 capture and destruction
- Reduction in emissions of sulphur hexafluoride (SF_6)
- Sequestration of carbon due to afforestation
- Reduction or avoidance of CO_2 emissions from natural gas, oil, or propane end-use combustion due to end-use energy efficiency in the building sector
- Avoided CH_4 emissions from agricultural manure management operations

The RGGI offset programme provides largely standardised approaches to baseline scenario selection. Project developers are not required to undertake any project-specific analysis of baseline alternatives. However, most of the prescribed baseline emission calculation methods include significant project-specific parameters (Broekhoff 2007, RGGI 2008).

In order to avoid the complexity of the case-by-case additionality demonstration approach taken under the CDM, the programme established a "standardised approach" to additionality demonstration, using specifications on technology or practice and performance standards. Namely, these specifications or performance standards are proxies that may be used to infer financial additionality. They are used independently or in tandem (RGGI 2007, RGGI 2008). As RGGI just started its operation in 2009, the update schedule of these standards has not yet been announced:

- **Specifications on technology or practice** are a qualitative eligibility criterion for a category of projects that reasonably ensures that a project is unlikely to occur under standard market practice. For instance, such specifications are used as an eligibility criterion of the landfill CH_4 capture and destruction category that "offset projects shall occur at landfills that are not subject to the New Source Performance Standards (NSPS) for municipal solid waste landfills".
- **Performance standard** is a quantitative eligibility criterion that establishes a metric for determining if categories of projects are unlikely to occur under standard market practice. Examples of performance standards include (1) an

[26] For details of the trigger prices, see RGGI (2007).

emissions rate, (2) energy efficiency criteria, and (3) a market penetration rate.

Emissions rate standard: For example, a SF_6 reduction project is deemed additional if it reduces SF_6 emissions beyond a certain threshold pre-defined by region. The thresholds for five US regions are determined based on the weighted-average 2004 emissions rates for US EPA SF_6 partnership utilities in each region. Even if the threshold is not met, a project can still be additional if the project is being implemented at a transmission and/or distribution entity serving a predominantly urban service territory and there exist at least two barriers, out of the pre-defined six barrier categories, that prevent optimal management of SF_6.

Energy efficiency criteria: In order to assess additionality of energy efficiency projects, the rule stipulates efficiency criteria based on installation best practice and whole-building energy performance. An example of the former is a minimum efficiency level set for boiler efficiency, while an example of the latter is a requirement to exceed the building energy performance requirements of a certain building code by e.g., 30%.

Market penetration rate: An example is the use of a 5% market penetration rate to assess additionality of energy efficiency measures and manure management by anaerobic digesters. The market penetration determination shall utilise the most recent market data available.

3.2.7 Summary of findings

The survey of the existing initiatives shows that performance standards and performance comparisons are used in a variety of contexts (e.g., baseline setting vs. additionality demonstration, allowance allocation under ETS vs. offsetting vs. voluntary performance measurement), and sometimes with varying definitions (e.g., the “qualitative performance criterion” used in RGGI is akin to a positive list). With the exceptions of the CSI and the IAI, which have already established very standardised GHG protocols on a global scale, the existing standardised approaches are highly diverse and often ad-hoc, and thus require further harmonisation. The following section will summarise the key lessons learnt from the existing standardised approaches according to the key methodological aspects of performance standards implementation: (1) aggregation level, (2) data requirements, (3) stringency, and (4) updating frequency.

Aggregation level:

- **Process aggregation:** One of the major divergences in standardised approaches is found in the treatment of differences in technology or process. A trade-off exists between the higher accuracy in emission reduction calculation and the increased transaction costs that a disaggregated performance standard will produce. The EU ETS experience indicates that it is important not to disaggregate performance standards by technology or process in too much detail.

- **Product aggregation:** All of the performance comparisons use product or service-specific indicators (e.g., in t CO_2/t product, kg CO_2/distance travelled). Product aggregation is in most cases kept at a high level, and detailed aggregation is not common.
- **Temporal aggregation:** The CSI and the IAI, the voluntary performance measurement initiatives, do not differentiate by plant vintage. On the other hand, the standardised approaches for new and existing installations are usually differentiated in the EU ETS and the US offset programmes[27].
- **Spatial aggregation:** No consistent observation can be made. The system boundaries in the EU ETS standardised allocation system are not defined consistently across Member States. The CSI and the IAI use a global performance standard approach. The US offset programmes apply a state, regional, or national boundary.

Data requirements: In most cases, performance standards are established based on empirical data obtained in recent years. However, the data requirements of the EU ETS standardised approaches for the allocation of free allowances for new installations are somewhat ambiguous, as they often refer to BAT without specifying how it is to be defined. The US offset programmes attempt to reduce data requirements as much as possible by introducing default parameters. Such standardisation benefits from improved usability of the methodologies but bears a risk of higher uncertainty in emission reduction calculation. In addition, the CSI experience shows the importance of independent data management to increase transparency in the performance comparison process and to safeguard the confidentiality of the collected data.

Stringency: The choice of stringency level is very diverse. Standardised approaches for new installations often use BAT as the performance standard. However, the definition of BAT is not always clearly given. Therefore, it is important to clearly identify what the BAT is in the relevant boundary. On the other hand, the performance standard for existing installations is usually determined by a percentile level (e.g., top x% performance in a certain boundary). The stringency level varies from the top 10% to the top 50% (i.e., average). Determining the “right” level of stringency requires detailed technical and economic assessment in the sector.

Updating frequency: The frequency of performance standard update differs by performance comparison initiative surveyed. The voluntary initiatives, the CSI and the IAI, update performance levels every year. The EU ETS standardised approaches for the allocation of allowances are updated only at the end of each trading period, as the performance standards are used for initial allocation of

[27] This is in line with the CDM approach, where existing installation projects normally assume the continuation of the historical emissions as the baseline, whereas the baseline of new installation projects is based on the most economically attractive course of action, taking barriers into account.

allowances. The US EPA's Climate Leaders Programme plans for regular updates (every 5-8 years) but the frequency will likely differ by project type. Other US offset programmes have not announced regular updating schedules.

Additionality demonstration: The US offset mechanisms give important insights into standardisation of methodologies. All three US offset mechanisms surveyed state that they apply the performance standard approach for the demonstration of additionality. However, in reality they use a mix of performance standards and positive technology lists, where the reasons for choosing the approach are not really defined objectively. In particular, additionality determination is relatively ad-hoc. Thus caution has to be exercised on the question of whether these approaches could be used in the standardised approach-based CDM.

3.3 Emerging use of standardised approaches under the CDM

Performance standards have also been used in CDM methodologies, though so far only to a limited extent. This is mainly because of the difficulty in collecting extensive data for the performance comparison. Such data is often confidential and particularly difficult to obtain if competitors are to be included among the comparison peers. Further, there is a split incentive in that benefits from standardised approaches could be globally accessible, while the data collection burden is put solely on a project developer. As opposed to the top-down initiatives surveyed in Ch. 3.2, such a bottom-up approach to data collection has not been successful. Therefore, the existing standardised CDM methodologies based on a performance standard have focused on sectors where a large body of data is already available (e.g., power, aluminium, cement).

To the end of improving the efficiency of the CDM, further standardisation of baseline methodologies is called for. For example, at its Barcelona meeting in November 2009, the AWG-KP contact group on emissions trading and project-based mechanisms emphasised the importance of this issue in a "chair's non-paper". The non-paper explicitly mentions as one of two options[28] the need to standardise baselines by establishing parameters, including performance standards, and procedures for the determination of additionality and the calculation of emission reductions (UNFCCC 2009e). This section aims to analyse the standardised approaches found in existing CDM methodologies, and draws general lessons for elaboration of standardisation in the CDM.

[28] The other option is, "No decision to be made with respect to this issue."

3.3.1 Standardised baseline emissions calculation

This section gives an overview of the standardised approaches for baseline emissions calculation employed in the existing approved CDM methodologies. We identified the following key methodologies for the analysis:

- Tool to calculate the emission factor for an electricity system (version 2).
- AM0030: PFC emission reductions from anode effect mitigation at primary aluminium smelting facilities (version 3).
- AM0037: Flare (or vent) reduction and utilisation of gas from oil wells as a feedstock (version 2.1).
- AM0059: Reduction in GHGs emission from primary aluminium smelters (version 1.1).
- AM0063: Recovery of CO_2 from tail gas in industrial facilities to substitute for the use of fossil fuels for production of CO_2 (version 1.1).
- AM0067: Methodology for installation of energy efficient transformers in a power distribution grid (version 2).
- AM0070: Manufacturing of energy efficient domestic refrigerators (version 2).
- ACM0005: Consolidated Baseline Methodology for Increasing the Blend in Cement Production (version 5).
- ACM0013: Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology (version 2.1).
- ACM0015: Consolidated baseline and monitoring methodology for project activities using alternative raw materials that do not contain carbonates for clinker production in cement kilns (version 2).

These methodologies are assessed below in terms of the four key methodological issues for performance comparison: (1) aggregation level, (2) data requirements, (3) stringency, and (4) updating frequency. The detailed results of the analysis are found in Annex II.

Aggregation level:

- **Process aggregation:** Differentiation of performance standards by technology or fuel type is observed for half of the methodologies surveyed. The choice of technology (non-)differentiation seems ad-hoc, as project categories with potentially highly diverse technological choices (e.g., chemical production in AM0037, CO_2 production in AM0063) do not require such differentiation while others with relatively limited technological variations do (e.g., efficient refrigerators in AM0070).
- **Product aggregation:** Performance standards are universally established on a product or service-specific basis. Further disaggregation of the product or service is not common. For example, AM0063 could have differentiated the CO_2 product by CO_2 purity, but it uses CO_2 as a broad indicator. There are only two methodologies that narrow down the product category, i.e., primary aluminium as opposed to aluminium in general (see AM0030 and AM0059).

But these aluminium methodologies are applicable to the smelting process of aluminium production, which only takes place in primary aluminium production sites (not in secondary aluminium production sites). Therefore, their aggregation level is a natural choice. In sum, detailed disaggregation is not common in the product dimension.

- **Temporal aggregation:** The majority of the methodologies set temporal thresholds for the choice of peers for comparison. The threshold is typically set as the "most recent five years"[29], but there are deviations such as "the most recent 10 years" (CO_2 recovery in AM0063), "the most recent year" (efficient refrigerators in AM0070), and "no differentiation" (clinker production in ACM0015). Standardised approaches for facilities or products with long lifetimes of capital stock tend to set longer timeframes for the threshold.
- **Spatial aggregation:** Most of the methodologies set the geographical boundary as the host country, the grid system, or a certain distance from the project activity. However, the boundary is expanded for commodities traded beyond a national boundary (e.g., aluminium). Furthermore, a few methodologies define a minimum sample size for calculation of the performance standards, and require the boundary to be expanded until the sample size is met.

Data requirements: In most cases, performance standards are established based on the empirical data from the most recent year or the most recent three years. No projection-based data is used in the methodologies surveyed. A few methodologies allow for the use of conservative default factors or alternative data such as manufacturer's specifications.

Stringency: The dominant choice is "the average of the top 20% performers", which is apparently derived from the baseline approach 48.c of the Marrakech Accords. ACM0013 deviates from this trend and uses the top 15% instead. However, this is the result of the political compromise of the CDM EB after a long and heated discussion over whether or not coal power projects should receive CERs at all. Hence, the use of the top 15% is considered an exceptional case. The top 20% clause of the Marrakech Accords has been the common basis for defining the stringency level. Detailed technical judgements on the "right" level of stringency for the performance standard have not been developed.

Updating frequency: The majority of the methodologies require updating of performance standards only at the renewal of a crediting period (CP), i.e., every seven years. Annual updating is required by ACM0005 (cement blending), AM0070 (efficient refrigerators), and the Tool to calculate the emission factor for an electricity system (renewable power; only if an ex post option for calculation of performance standards is chosen). The first two methodologies provide a default value for the annual updating of performance standards.

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[29] This is likely referenced to the requirement of the baseline approach 48.c of the Marrakech Accords. The 48.c approach determines the baseline emissions as emissions of the top 20% of similar project activities undertaken in the previous five years.

3.3.2 Standardised approach to additionality demonstration

Market penetration rate approach

Some elements for standardisation of additionality demonstration can be found in the existing approved methodologies. For example, AM0014 “Natural gas-based package cogeneration (version 4)” employs an approach to performance standards similar to that used in the US offset mechanisms (see Ch. 3.2). As an alternative option to the investment analysis, this methodology provides procedures for additionality demonstration based on a market penetration rate, e.g., a project is considered additional if:

- Less than 10% of the economic cogeneration potential in the host country has been realised, or
- The project fulfils the following conditions:
    - The installed cogeneration capacity accounts for less than or equal to 5% of the total installed thermal generation capacity in the host country, and
    - The installed cogeneration capacity in the host country is less than or equal to 500 MW, and
    - The installed number of cogeneration plants in the host country is less than or equal to 25.

ACM0005 also uses a market penetration rate approach. The project is deemed additional if the market share for blended cement in the host country is below 5% during the last three years prior to the implementation of the project activity.

Quantified performance standard values as in the above examples could provide certainty to project developers and help streamline the often subjective additionality demonstration procedure. But the choice of the threshold needs a judicious analysis of the parameters differentiating BAU projects from those that go beyond BAU.

Emission rate approach

Furthermore, it is worth noting that AM0070 explicitly uses a standardised level for both baseline emission calculation and additionality determination. The rationale for the standardised additionality approach is stated in AM0070 as follows:

A benchmark approach is used because project activities under this methodology can involve a range of energy efficiency improvement measures, implementation of which will be spread over the duration of the crediting period. For this reason, it would be difficult to undertake a solid barrier or investment analysis for the whole range of measures at the start of the project activity. Moreover, the benchmark approach provides a good basis to assess whether the efficiency of refrigerators *manufactured under the project activity exceeds what is the common practice in the respective market.*

In general, the same logic can be applied to projects implementing a range of technologies or measures at various points in time over the crediting period. Therefore, AM0070 is considered an important stepping stone to further standardisation of CDM methodologies.

Careful consideration should be given to whether standardised levels for baseline emissions calculation and additionality demonstration are to be differentiated. AM0070 uses the same level of stringency (top 20% level) for both purposes (single standardised level for both baseline and additionality demonstration). On the other hand, the recently submitted CSI standardised cement methodology explicitly differentiates the two levels (standardised baseline and distinct additionality performance standard): it uses the top 20% level for additionality demonstration, and the top 45% level for baseline emissions calculation (CSI 2009a). As the following conceptual analysis shows, whether the single or dual standardised level approach makes better sense largely depends on the project type (e.g., new vs. existing installations).

First of all, it is important to keep in mind that the baseline can only determine additionality if it is defined by economic parameters. This is the case of the baseline approach 48.b of the Marrakech Accord, where the baseline is the most economically attractive alternative (Michaelowa 2005). We now consider standardised approaches for new installation projects and make two assumptions. First, a performance standard is set at (or beyond) the level that represents the most economically attractive alternative. Second, this performance level does not differ significantly for entities in the sector. Given these assumptions, the single standardised level is adequate for both baseline emission calculation and additionality demonstration, as the chosen level is determined by the economic analysis. The first assumption requires that some kind of sector-wide investment analysis be conducted. Though the second assumption is debatable, the uncertainty is much lower for new installation projects, as the investment analysis is not affected by the configuration of the existing installation and it is likely that the new BAU installations would represent an emission level close to the BAT in the market. The variance of the baseline emission level is limited and it is likely that there are few non-additional measures beyond the baseline level. Thus, **a single standardised level is suitable for both the baseline setting and the additionality determination**.

As to existing installation projects, it is reasonable to set a performance standard less stringent than the one for new installations, as it is usually technologically impossible to bring an existing plant to the performance level of a new BAT plant. If the performance standard is set at a moderate level of stringency, however, it is more likely that non-additional measures would be credited against the standardised level. This would yield “phantom” emission reductions (false positives). The challenging issue is that each existing installation in the sector could insist that its historical emission level is the true baseline level for the entity, and that this should be reflected in the sector-wide standardised baseline level. As compared to the new installation case, the variance in historical performance levels in the sector is very large (Figure 6).

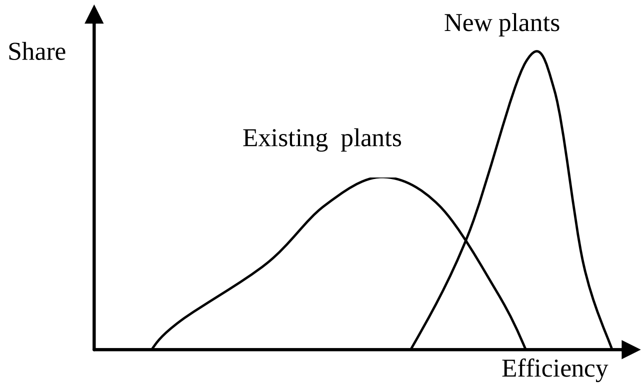

Figure 6: Variance in performance levels for new and existing plants

Therefore, setting a standardised baseline would entail a greater amount of uncertainty in emission reduction calculation. In addition, mitigation options available to existing installation projects would likely cost less than those available to new installation projects. Consequently, existing installation projects have a higher likelihood of free riding. For these reasons, **it makes sense to apply a standardised level for additionality demonstration that is separate from and more stringent than the standardised baseline level.** Ideally, the standardised additionality demonstration needs to be set at a level at which, on average, the amount of lost mitigation opportunities due to the stringent standardised additionality level (false negatives) offsets the amount of phantom emission reductions (false positives). This would require a good knowledge of the possible technical improvements due to refurbishment of existing installations and the costs required for such improvements. This has to be based on a sector-wide assessment of the amount of non-additional measures beyond the set standardised baseline level. A key parameter that should play a role in setting the standardised levels is the vintage of the installation (Figure 7).

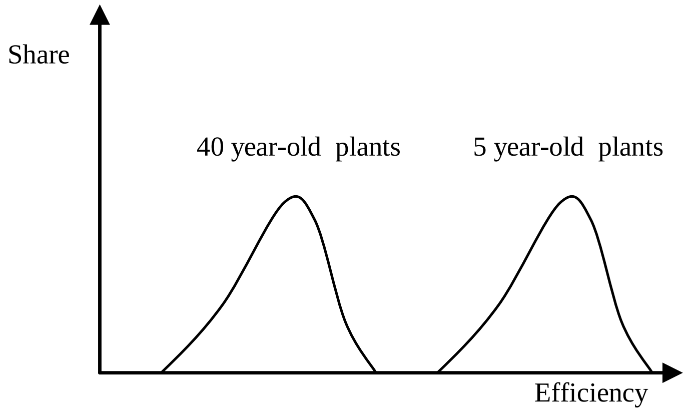

Figure 7: Variance in performance levels for different vintages of existing plants

The key characteristics of new and existing installation projects as well as pros and cons of the standardised additionality level approach for these project types are summarised in

Table 2.

Table 2: Standardised additionality level for new and existing installation projects

	Key characteristics	Preferred approach
New install-ation	• Small variance in the baseline emission levels in the sector. • Limited amount of low-cost measures beyond the baseline level.	<u>Single standardised level for baseline and additionality</u>: • The standardised level is likely set at the level of a new BAU installation, defined by economic parameters. The most economically attractive baseline scenario justifies the use of the baseline for the additionality demonstration. • The small variance in the baseline emission levels and the limited risk of free riding favour the single standardised level approach in determining real emission reductions.
Existing install-ation	• Large variance in the baseline emission levels in the sector. • Low-cost measures are likely widely available beyond the baseline level.	<u>Dual standardised levels:</u> • The large variance in the baseline emission levels and the greater risk of free riding would result in large uncertainty in emission reductions if determined by a single standardised level. • The standardised level needs to provide sufficient investment incentives by setting a standardised baseline at a moderate stringency level, while it needs to minimise the risk of free riding by setting a stringent performance standard for the additionality.

4. Methods for establishing standardised approaches under the CDM

– Summary –

Developing standardised approaches under the CDM can be complex, as identical schemes cannot be applied to all sectors. However, experience has shown that this complexity can be mastered. The three key elements required are an adequate selection of entities to compare, appropriate performance standards levels, and updating of performance standards.

Comparison against the right set of peers is essential for any standardised approach. An appropriate level of aggregation can help filter out projects whose characteristics are not representative of the baseline. A key requirement for the design of standardised approaches is an in-depth understanding of the key parameters that influence the level of performance of entities in a specific sector. **Disaggregation of standardised approaches enhances the ability to identify additional projects.** One of the most important grounds for disaggregation is the distinction between new and existing installations. Further important parameters for disaggregation are product homogeneity and the geographic availability of certain resources to supply the target market. Local conditions can have a large influence on additionality as well.

In general, sectors appropriate for standardised approaches **produce outputs or services similar in their nature and in their production processes.** Ideal sectors are also **highly concentrated, with limited geographical factors affecting the level of GHG performance,** and already have **a large amount of data available** for standardised approaches. Therefore, standardised approaches are likely to be a suitable instrument for large and homogeneous sectors. For other sectors not amenable to standardised approaches based on a performance comparison, alternative approaches (e.g., default parameters) have to be considered as a fall-back option.

Setting the right level of stringency for baseline and additionality is essential. The choice of levels has to ensure a balance between credited emission reductions calculated by the standardised approach and real emission reductions generated. No generic numbers can be used for setting baseline and additionality levels. Instead, **the determination of specific levels for additionality and baseline should rely on expert judgement and an in-depth technical and economic knowledge of the specific sector.** A large body of objective data that can inform the decision, such as knowledge of BAU practices and technology costs, is available.

As performance of a sector changes over time due to autonomous technical progress, performance standards need to be updated. This is especially important for existing installation projects, which are more likely to see autonomous technological progress over time, including both technical and operational measures. For new installations, most of the measures are expected to be implementation of specific technologies, and they would normally last until the end of the crediting period. In this case, the baseline level should be fixed for the crediting period applicable to the project, or only be updated according to parameters which can be improved without major technical upgrades.

In order to prevent large risks in the actual implementation of standardised approaches, a test run of the approach is desirable. Self-correcting systems can also be incorporated in the design, thus further lowering the risk. It should be kept in mind that there is a **trade-off between the transaction costs incurred by disaggregation and by updating of performance standards, and the accuracy of the standardised approach**.

4.1 Peer data comparison: the level of aggregation

Establishing performance standards does not come without difficulties, as already seen with the set up of the EU ETS and the few efforts towards standardised approaches in the CDM. When developing an adequate standardised approach for the CDM, numerous parameters have to be taken into account. This section summarises the key issues related to peer data comparison, one of the most important steps in standardised approaches. As the range of projects, sectors, technologies and circumstances in the CDM is extremely large, only a limited number of common principles can be identified. As such, this section provides a list of elements which need to be considered when developing a standardised approach. Its relevance is expected to vary widely, depending on the sector or product.

Once KPIs have been identified to establish which metrics the CDM project is to be assessed against, the scope of the comparison has to be defined. The level of aggregation plays an important role in identifying the appropriate set of peers for comparison.

The purpose of aggregation is not arbitrarily to choose additional projects (Hampton et al. 2008). Instead, the role of aggregation is to provide a procedure to refine the scope of comparison in order the better to extract projects and measures which are considered to be additional. As discussed in Ch. 3.1, four key dimensions are identified: (1) process, (2) product, (3) time, and (4) space. In the following, we examine further details of these four dimensions.

4.1.1 Process aggregation

Sector and process: In Ch.2.1, we pointed out the low mobilisation of specific sectors in the CDM. Performance standards within the CDM relate to a specific economic output. This economic output is either a product (e.g., steel) or a service (e.g., transportation). Any performance standard can only compare one or more well defined outputs. As the same product can sometimes be produced or used by different sectors, the sector should only be considered as a complement of information for the product. However, the right product should be selected in order to mobilise a maximum of emission reductions throughout the sector with respect to available data. For example, for countries in which data is not yet available for the whole steel production process, a performance standard could focus on the production of crude steel instead of all of its downstream products. This would allow for coverage of most of the emissions and still take into account a large emission reduction potential. However, **it is important to define a clear, uniform system boundary for a specific sector** in order to account for the same scope of emissions for the defined product. For example, a clear set of rules should provide guidance on whether trucks and buildings of the cement industry should be accounted toward the production of the cement sector or not.

System boundary: System boundaries define the set of activities to be taken into account for emissions (or energy use) in the performance standard. Choices of system boundaries are often arbitrary. A standardised approach based on a performance comparison can encompass either single technologies or activities, partial production processes, or entire production chains. For example, the on-site extraction of raw materials for industrial processes can be seen either as a distinct activity or as part of the larger scope of the main production process. Also, on-site transportation can be considered as either part of the system boundaries or not.

A restricted scope for system boundaries tends to reduce the need for data and monitoring, as fewer elements are considered. In some cases a narrow scope for system boundaries can reduce the complexity of setting up performance standards while preserving the largest potential for emission reductions. For example, a standardised approach for the steel sector can be restricted to the production of crude steel instead of the different types of downstream products manufactured on-site from crude steel. Because they interact with other components in the system, the performance of single technological sub-components might be difficult to measure accurately, as experience in the CDM has also shown (e.g., single-measure assessment in energy efficiency projects). Hence a restricted system boundary is not recommended for highly integrated processes with complex flows and interaction between multiple sub-components.

A broad system boundary enables the inclusion of a maximum number of processes, thus increasing the scope of emission reduction measures that can be implemented. Consequently, more measures can often be mobilised at a lower transaction cost under the same standardised approach. A broader system boundary might increase the need for monitoring as more sub-processes might need to be monitored and more inputs or outputs might need to be taken into account. As more related activities are included within the system boundaries, the number of activities outside the system boundaries which have to be considered for possible leakages decreases. This is the case for example if on-site transportation is included.

Ultimately, there is no generic rule that can be applied to the selection of system boundaries. The choice of system boundaries largely depends upon the processes and their complexity. **The choice has to be made on a product/sector-specific basis, taking into account possible trade-offs between complexity, coverage**

and ability to mobilise emissions. The ability to gather adequate data should be taken into account when deciding on system boundaries. In order to ensure fairness, a uniform definition of system boundaries should be used.

Technology differentiation: Comparable outputs can be produced from different technologies within a sector (e.g., steel produced from direct reduced iron vs. steel produced from the Blast Oxygen Furnace – Blast Furnace (BOF-BF) technology). Comparable outputs can sometimes even be produced from different sectors (e.g., CO_2 recovered for industrial purposes from the power industry and CO_2 produced as a co-product from the chemical industry). **Technology-specific performance standards, though theoretically feasible, are not necessarily the most suitable approach for the CDM.** Technology differentiation is not adequate for new installation projects which may have wide technology options for investment.

However, technology differentiation can be useful in case the use of one or more technologies is either not fulfilling the legal requirements, not available, or not realistic for economic or technology-related reasons. This procedure of elimination of technologies is already present in the CDM via the tools used to identify the baseline scenario and demonstrate additionality. Similarly to the present application of the CDM, if several technologies are available to users, the performance standard could be based upon the alternative with the lowest specific emissions.

Levels of performance related to a specific technology could be used for the additionality demonstration in the CDM if it is known that a certain technology will not be implemented under BAU due to financial barriers or prevailing practices. This is the case for example with new technologies in the process of entering the market and/or in the process of achieving market penetration. In a technology penetration-based approach, a certain technology could be deemed additional until it has been deployed to a certain scale. For example, Concentrated Solar Power (CSP) could be deemed additional until it has reached a certain installed capacity in the relevant geographical boundary. The standardised baseline level could then refer solely to units using the BAU technology (technology A) until a certain rate of market penetration has been achieved. Beyond that threshold, the baseline could be lowered by increasingly incorporating the new technology (technology B).

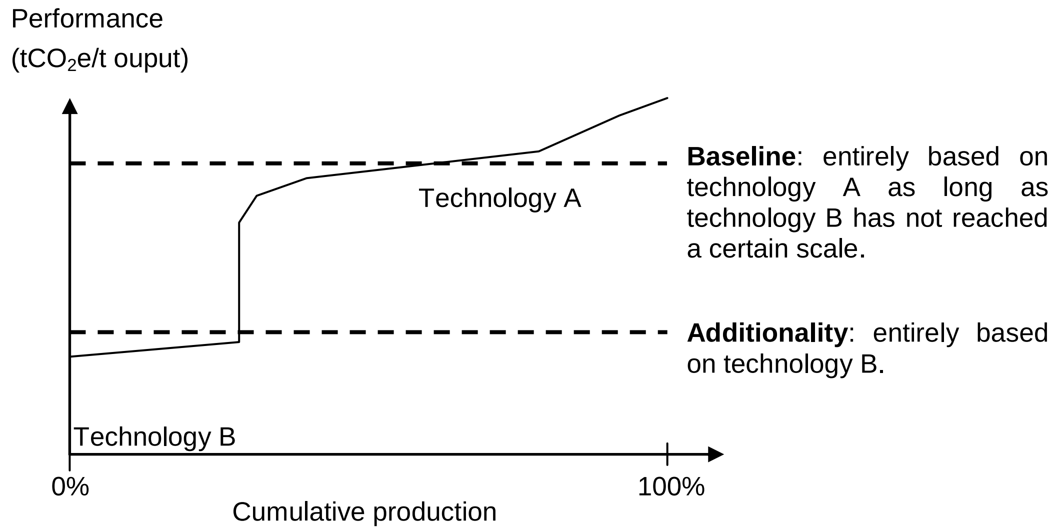

Figure 8: Technology-related performance standards

Technologies that are deemed additional could be excluded from the cohort used to determine the baseline until a certain number of them have been built through purely commercial finance. Units using the specific technology could from then on start being added to the peers to compare against, thus lowering the baseline and reducing the incentive for investment. Performance standards could also directly use a technology or a technology penetration rate as a basis for the additionality demonstration, and rely on a technology-based cohort for setting the baseline. For example, as illustrated in Figure 8, the performance standard could be entirely based on a certain technology A as long as technology B has not achieved a certain scale, for example defined as X GW power generation installed or X% of the market for new units.

Finally, technologies can also be used as a fall-back option for making assumptions about missing performance data. When no further data on the exact performance is available but the technology is known and only a minor spread in performance for a given technology exists, assumptions about the performance level can be derived from the technology used. This is the case for example with chemical processes in which practices have only a minor influence on the global efficiency of the process.

Scale: The scale of a plant or unit can influence the emission performance (e.g., economies of scale). However, **scale is generally not an adequate parameter for aggregation unless specific conditions are met.** Larger-scale units are often able to provide the same service more efficiently than smaller-scale ones (e.g., a large-scale power plant compared to a small-scale power plant). However, the deployment of large-scale units is not always possible due to a restricted scale of demand from possible users. This can justify a threshold based aggregation. One example would be for a new cement plant to supply local markets in the Himalayas: only a limited local market exists with no realistic efficient trading to and from the local area. This is also the case for individual air-conditioning (AC) units in which the scale of the demand is restricted to the housing unit unless building-wide cooling or district cooling can realistically be implemented. For existing plants, however, the threshold might be a useful parameter to take into account in order to create a performance standard reflecting their specific conditions. Aggregating plants by their threshold could help to set the right incentive for existing plants to improve their specific emissions.

Load regime: The load of a specific equipment expresses the ratio between the real output and the theoretical maximum (i.e., if the equipment were to be used at full capacity over the year). It can be differentiated into load classes. The load regime can strongly influence the efficiency level. This utilisation of the equipment can be linked to a specific demand in the market and/or be related to repair and maintenance practices. **For most types of output, no differentiation of performance standard according to load regime should be included.** Exceptions are outputs for which the load regime is directly linked to the quality of the product or local conditions. This is the case for example in the production of electricity, where loads should be differentiated into base load, intermediate load and peak load. This is also the case with demand for building cooling and heating, and with any other activity that is tied to local patterns beyond the control of the project proponent, such as climate and weather, and that can only be supplied by other entities exposed to the same local patterns.

4.1.2 Product aggregation

The comparability of outputs is a key factor of success for performance standards. Sufficient comparability is needed for objective and fair performance standards. Key parameters that can limit the comparability of products are their homogeneity, the types of inputs, the number of outputs (in case several are produced), and also the correlation between processes or outputs and key parameters. Outputs can either be differentiated according to product quality or not. An analysis of this aspect of differentiation is needed for a proper standardised approach. We distinguish the following dimensions for consideration:

Homogeneity:

(1) Homogeneous outputs: Homogeneous products or services are well suited to standardised approaches. This category includes products which are either identical or similar enough that they can be accurately compared without any other adjustment. Commodities for example are fully identical products which are solely differentiated by price. This category includes, among others, electricity, primary aluminium, drinking water, flat glass, and domestic hot water. Also, most chemical products (e.g., ammonia, methanol, urea, ethylene, hydrogen, oxygen, nitrogen) show either little or no differentiation.

(2) Interchangeable products: For many applications, similar products with different properties are found. Although differing properties limit the use of products for certain applications, the room for substitution is extremely large. This possibility for substitution makes the use of a common performance indicator possible and acceptable. This is the case for example with most cement types, which are interchangeable. This might also be the case to some extent for residential units. Also, cooling for residential units with a largely comparable range of cooling temperatures falls into this category.

(3) Products differentiated based on one or more parameters: Certain types of outputs have an emission intensity which is correlated to their properties (e.g., temperature, strength, thickness, purity). Such properties can be related to the quality of the product or to the specifications of the product. An example is Ordinary Portland Cement (OPC), whose strength increases with a finer grinding, which requires more electricity. There also tends to be a relationship between the quality of the outputs and the associated indirect emissions.

In addition, the properties of a product can play a major factor in emission intensity. Energy consumption per tonne of flat glass is correlated with the thickness of the output (Ecofys/Fraunhofer ISI/Öko-Institut 2009b). On the other hand, the efficiency of a coal-fired power plant is affected by the quality of fuels used.

A case of specific emissions influenced by the quality of the inputs is the refining of oil products. Crude oil qualities are heterogeneous and show extremely large spreads in purity and heat content. As such, levels of energy required to turn them into quite standard products with specified qualities (e.g., regular gasoline, kerosene) are strongly influenced by the input used.

Most of these parameters can be taken into account as long as specific emissions for the product can be clearly modelled as a function of the parameters. Thus, even products for which one or more parameters influence the level of performance can be compared against another.

Demand situation: The balance between demand and supply has a strong impact on the appropriate cohort of installations to be considered in standardised approaches. In many sectors in developing countries, demand exceeds supply, leading to “suppressed demand”: In this case, a specific demand is not satisfied due to the lack of output. This is the case for example with electricity in fast growing countries. Applying a performance standard for capacity expansion based on the performance of previous new plants in this case can be unfair. If, on the other hand, production capacity is much larger than demand, further additions to capacity would not displace other new plants but instead lead to the retirement of existing plants. In such a case, arguably new plants should be compared to existing ones.

Number of outputs: Certain sectors have solely one type of output while others have a large variety of different outputs. Similarly, inputs of sectors can range from only one single product to a very large number of them. In general, **the complexity of any standardised approach is mainly related to the number of outputs of a certain sector or process.** In the case of a large number of inputs for one single product, all inputs are related to the production of the single product. As such, all possible sources of GHG emissions can safely be assigned to the production of the single output without any doubt. With several outputs from one single input, assigning the emissions to the products becomes less straightforward (e.g., cogeneration of heat and electricity). Consequently, an approach to assigning a certain share of the emissions to the different products is needed. This approach is called "apportioning". In the case of several outputs with many different inputs, apportioning can be highly complex (e.g., the chemical sector).

However, experience with several complex sectors such as petrochemicals, steel or complex co-generation systems has shown that complexity related to a high number of outputs can be managed. Different apportioning procedures may be available, with no one procedure more suitable than another. In this case, the choice of an apportioning procedure is to some extent political in nature.

Comparability in inputs: Inputs can be a key parameter for comparability. In several cases the type of input used influences the level of performance or technology. This is the case for example in the iron and steel industry, in which secondary steel can only be produced with a sufficient supply of scrap steel. As the supply for scrap is limited, however, it is generally not possible to meet the increased demand for steel with secondary steel.

Generally, differentiation according to inputs should only be considered if the project developer does not have access to the specific input, due either to the non-availability of the resource, or to applicable regulations. As limited access to specific inputs might be a local factor, aggregation related to inputs will further relate to geographic parameters. In cases where the product/good could have been supplied to the user without restrictions relating to the type, quality and amount of available inputs, differentiation along these lines is not desirable.

Table 3: Complexity of performance comparison with different inputs/outputs

	Several inputs	Single input
Several outputs	**Very complex:** Coal, coke, natural gas, oxygen, electricity and iron ore used to produce various different steel products.	**Complex:** Natural gas used to produce cogenerated power and industrial heat.
Single output	**Simple:** Electricity, coal, waste fuels and limestone used to produce cement.	**Very simple:** Coal used to produce electricity; natural gas used to desalinate water.

4.1.3 Temporal aggregation

Vintage of the plant: The vintage of the plant can be an important parameter for disaggregation. We can distinguish between new and existing installation projects. Furthermore, existing installation projects could be disaggregated according to the vintage of the installation (based on the date of commissioning).

As a general rule, **performance standards should be differentiated by new and existing installations.** If necessary, further disaggregation of the existing installations by vintage class should be made. Due to technical progress, new installations are inherently more efficient than existing installations. Therefore, new BAU facilities would find it easier to beat a stringent performance standard based on existing installations. Therefore, only relevant plants which have been established over a given period of time should be used. The current approach 48.c. in the CDM specifies a baseline level as the average of the most efficient 20% of units built over the last five years in the region. As described below, it can however be argued that **the use of five-year data is not always appropriate**:

- **Low-growth sectors:** In some chemical sub-sectors, for example, the number of newly built installations worldwide is extremely low and little progress has been achieved worldwide, whether on energy efficiency or cost of production capacity. In this case, plants built even earlier than five years ago (e.g., 10 years ago) might still be representative of current conditions.
- **High-growth sectors:** As pointed out by Kempton et al. (2008), some sectors add many new, efficient plants. In such sectors, a more accurate comparison can be performed by selecting peers built very recently (e.g., in the last three years).

For existing plants, differentiation by vintage is generally possible, as dates of commissioning and/or construction are often available. As old vintages are unable to beat the stringent emission performance levels that new installations can achieve, performance standards must be differentiated by vintage classes (Figure 9).

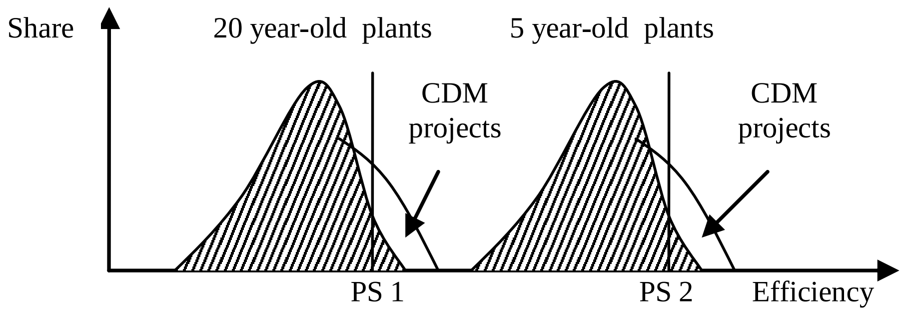

Figure 9: Performance standards according to different vintages of existing plants

Note: PS denotes performance standard. The figure assumes that efficiencies/carbon intensities of new BAU projects for 20-year and 5-year vintages are distributed according to the shaded curves. Projects that could be mobilised only through the CDM (additional projects) are shown in the non-shaded area. Any projects to the right of the level chosen as performance standard would be credited. PS 1 is used for the 20-year vintages while PS 2 for the 5-year vintages. Due to this differentiation, CDM projects are generated for both vintages, whereas making PS 2 valid for all vintages would have made projects impossible for the older vintages.

The above distinction would help avoid losing the potential for refurbishment of old installations. The performance standard would be valid only for the remaining technical lifetime of the refurbished plant. There is however a risk that trying to adapt the performance standard to extract measures which are known to be additional at existing plants will require customising the levels to the plant. Such an effort could be similar to a “case-by-case approach” and weaken the simplicity linked with a standardised approach.

4.1.4 Spatial aggregation

The relevant geographic area can be one of the major elements for disaggregation. Local parameters explain a substantial part of the differences in CO_2 intensities between countries. Local parameters also explain the large differences observed in the cost of and potential for emission reductions.

Fuel costs and availability: Large spreads in fuel costs, availability, quality and types (with different CO_2 intensity) are found throughout the world. **While in many cases such differences justify aggregation, this is not the case if the good or service could realistically be sourced in a region with a different set of fuel costs and availability.** This is due to the fact that the area of production is not identical to the area in which the good or product is consumed. A geographical disaggregation according to fuel cost and availability should be performed for an area in which the BAU scenario would supply the relevant market. For example, the relevant market for electricity in China is regional, so the aggregation should be based on this regional market. For speciality chemicals, however, the whole world is the basis for the supply. Therefore, even if low-carbon-intensive fuels are not locally available, no fuel aggregation should be performed.

Fuel costs and availability can be relevant for either a country, a region, or a group of countries. Aggregation based on fuel cost and availability requires the identification of an appropriate area with similar characteristics.

Other inputs: Availability of other inputs strongly influences the level at which a performance standard should be set, depending on the definition of the sector. The cement sector in particular can in many countries rely on the availability of slag, a by-product from the steel industry, to replace the CO_2 intensive clinker or fly ash from coal power plants. Thus performance standards might be too stringent for countries with little or no steel industry and no coal power plants, as this specific abatement option is not available. Without proper aggregation on this aspect, projects showing a clear deviation from the BAU case might not be able to gain registration.

Similarly, the steel industry can decrease its CO_2 intensity by injecting plastics as an alternative fuel and reducing agent. If such a practice were to become widespread, it could be argued by some plants that lack of plastic wastes limits their options for mitigation, and thus performance standards should be set differently.

A fair approach would take into account specific inputs available in the relevant geographic area supplying the market, and avoid the inclusion of plants which can source inputs not available to the majority of project proponents. In the absence of some specific available inputs to serve the market, a second fall-back performance standard can be used. This has been the main reason for CSI also to offer a clinker-based performance standard to plants that do not have access to substitution materials, instead of the cement-based performance standard.

Grid emission factor: One key issue is the treatment of indirect emissions related to the power consumption that is spatially dependent on the electricity grid serving the project. There are very large differences in grid emission factors. For all existing plants, the grid emission factor is not under the control of the project proponent. Only new plants producing internationally traded products will have the choice of the electricity grid in which to locate their plant.

Scope of trading: In many industrial sectors, interim products are consumed from third parties. The specific level of performance of this interim product is not under the control of the project proponent. For example, in the aluminium industry, some smelters produce their own alumina while others purchase their alumina. In order to construct an appropriate performance comparison, relevant information is needed on the level of emission intensity of such interim products. In some cases, only one supplier would realistically supply the interim products due to geographic, market or economic parameters. This is the case for example with unbundled cement plants in which the production of clinker and the cement grinding are located on two distant sites by the same company. In other cases, however, the supply of a certain interim product is an open market which can be global. In these cases, the average intensity of the worldwide production for the interim product can be used. The relevant emission intensity to be used for interim products should take into account the geographic boundary in which the interim products are traded.

Furthermore, where the output from the industry is internationally traded, the level of international trading will strongly influence the geographic scope appropriate for the standardised approach.

4.2 Determination of stringency levels

The definition of stringency for the standardised baseline and additionality levels pursues two key objectives:

- To ensure the global environmental integrity of offsets generated. This requires the real emission reductions generated to be equal or larger than the emission reductions credited.
- To achieve the mobilisation of the maximum number of emission reduction projects. This requires the registration of a maximum number of emission reduction projects.

Some projects can be identified as clearly additional, some as clearly non additional. However, a large “gray zone” remains. This gray zone corresponds to projects for which it is difficult to clearly demonstrate that the emission reduction measures would not have happened without additional financial support from the CDM. Whether to register such projects is ultimately a trade-off between the objectives of environmental integrity and maximisation of the CDM potential. Setting a right level of stringency is essential in order to strike a balance between non-credited real emission reductions (false negatives) and free riders (false positives). Fairness is another major issue for the baseline and additionality level, as not crediting a share of emission reductions from additional projects to compensate for free riders weakens the financial incentive. While some project types are fairly standard and do not pose particular problems for setting stringency levels, some project types require highly informed decisions for setting baseline and additionality levels.

4.2.1 General issues

Absolute vs. relative levels: Additionality or baseline levels can be expressed either as absolute values, for example in GJ, kWh or tCO_2e per unit, or as relative levels of performance. Relative levels of performance are calculated based on a certain set of plants selected out of the cumulative production capacity for their level of performance. Examples of relative levels of performance are the X^{th} percentile of the total cumulative production or the average of all plants between the X^{th} and the

Y^{th} percentile of cumulative production. Unlike absolute levels, which are fixed for a certain period of time, relative levels can be updated automatically with each new data collection. In turn, the level for additionality and baseline is likely to change with improvements in technology, and practices at existing plants, but also with the addition of new plants to the database (either new plants or previously unreported plants). **Performance standards expressed in relative levels are therefore suitable for capturing dynamic elements and self-correcting elements.** It has to be noted that a performance standard relying on a limited number of plants would be strongly influenced by major changes at a single plant. Typically, relative levels are used to characterise fast growing or evolving sectors with a large number of units. Absolute levels, while providing more stability, are better suited for sectors with greater inertia.

Stringency level for baseline: Baselines represent the level of specific emissions under the BAU scenario. Many scenarios can exist for baselines, most of which are hypothetical business scenarios (e.g., construction of a new plant, planned or discretionary retrofit). For most of these hypothetical scenarios a correct evaluation of the level cannot be performed ex-ante. However, projects in which the baseline is clearly the continued operation of an existing plant should be distinguished as representing a special case in which the baseline can be measured.

For existing units, in order to ensure integrity, any approach would need to apply the lowest of either the historical level or the standardised baseline level. A major risk in using such approaches for existing units exists only if BAU improvements on specific plants are observed well before the end of the technical lifetime of the equipment. In such cases the baseline level setting for existing plants would need to be sector specific and assess the risk of crediting BAU improvements.

For new units, baselines can only be a hypothetical business scenario, which makes performance standards an approach well suited to modelling the expected BAU case. For new projects, the availability of data on commercially utilised technology and local conditions and practices is key to establishing the appropriate level. A determination of a “common practice level” is expected to be a good approximation of the real additionality level and not to lead to over-crediting. The large difference between the “technical economic optimum level” and the “common practice level” has to be taken into account. Indeed, it has been observed that many cost-effective measures are not implemented due to a lack of awareness, conservatism and a need to minimise investments. New units only require a minor conservative adjustment in order to keep out of the pipeline what is expected to be the BAU scenario.

Sufficiently disaggregated approaches, if based on well informed parameters, can effectively represent baseline situations. A certain level of disaggregation is necessary in setting baselines, as BAU emission levels are likely to be linked to at least some local parameters. Due to the diversity of sectors, a one-size-fits-all approach as used in the Marrakech Accord, by setting the baseline at the average of the top 20% of performers, is not expected to be suitable except for the most basic technologies and sectors.

The baseline should be set slightly more stringently than the expected real baseline in order to avoid over-crediting and remain conservative. However, overly conservative baselines should be avoided in order to avoid weakening the incentive for real additional projects.

Stringency level for additionality: As noted by Broekhoff (2007), determining additionality at a specific level is a subjective process and replaces the subjective expert judgement used in case by case assessments.

Determining a level from which a certain project or bundle of projects is additional is sector-specific. The use of a common additionality level for all sectors is not possible. For technologies and sectors, a level at which a project is additional ranges from 0% (in the case of a sector in which the best possible technology is being used under the BAU scenario) to 100% (in the case of industrial gases in which all abatement is additional). Therefore, selected levels should rely on well-informed approaches using, if required, a higher level of disaggregation.

Ideally, a sector-specific study should report on the cost effectiveness of measures in the sector, in order to determine the stringency level of additionality determination. Also, the level of common practice should be assessed, as cost-effective measures are often not implemented (e.g., energy efficiency projects).

For projects at existing units, additionality determination often needs to be different from standardised baseline levels in order to avoid crediting non-additional improvements, such as BAU adjustments to the technical economical optimum. On the other hand, approaches have to be found which will ensure a sufficient incentive for improvement of laggards (see also discussion in Ch. 3.3.2).

4.2.2 A practical approach to assessing performance standards

For many sectors, setting baseline and additionality levels will require an in depth knowledge of economic parameters specific to the sector and the geographic scope used for the disaggregation.

A practical approach to assessing performance standards is to determine whether major choices of technologies or practices exist in specific sectors and to identify the drivers for implementing (or not) such approaches. Such drivers should be assessed in combination with possible levels of disaggregation that can be used.

Marginal abatement cost (MAC) curves and similar techno-economic analysis of mitigation options for a specific sector give insights into the technical economical optimum for a given sector. Overall, experts developing the standardised levels for baseline and additionality need to have a high level of confidence that the selected approach and particular standardised levels will ensure a balance between non-credited real emission reductions (false negatives) and free riders (false positives).

In sectors where this balance cannot be found with confidence, a test phase could be introduced. Such a test phase would mainly consist of a simulation of various projects using real data gathered from plants. The result of the simulation would allow an ex-ante estimation of the conservativeness of the selected approach as well as the specific risks expected. Results of the simulation could be discussed with industry experts.

4.3 Updating of performance standards

As performance of a sector changes over time due to autonomous technical progress, performance standards need to be updated. Updates of performance standards generally have the effect of increasing the stringency of the baseline over the crediting period, as performance of peers improves over time. This would in turn have the positive effect of cutting the generation of CERs at plants not keeping pace with improvements implemented by similar entities, especially regarding non-technical measures such as operational improvements. Such measures are widely available for existing installation projects, hence they would require frequent update of performance standards.

For new installations, most of the measures are expected to involve implementation of certain technologies, as opposed to soft measures (e.g., operational improvements without investment in concrete technologies or measures). And they are usually expected to be in operation until the end of the crediting period. In this case, the baseline level should either be fixed for the crediting period applicable to the project, or be updated only according to parameters which can be improved without major technical upgrades (e.g., fuels, alternative materials).

In order to capture the autonomous improvement of BAU new plants, **an improvement ratio can be calculated and applied to the performance standards.** This can be done either on the basis of historical data or using actual performance data of new plants commissioned each year. The use of an autonomous improvement ratio extrapolated from historical data instead of a yearly data collection reduces the burden of data collection but might lead to an unrealistic performance standard if done over several years, especially if a break in the improvement pattern is taking place (e.g., the sudden increase of energy intensity in Chinese heavy industry in the early 2000’s after two decades of strong autonomous improvement). Similarly, a degradation factor can be calculated in order to simulate the decrease in performance which would have taken place without measures such as maintenance and good housekeeping.

4.4 Sectors amenable to standardised approaches

It appears that standardised approaches can be applied to many sectors, as choices in the design of standardised approaches are large. In practice, specific characteristics of some sectors make them inherently more amenable to standardised approaches than others. In general, sectors appropriate for standardised approaches produce outputs or services similar in their nature and in their production processes. Also, ideal sectors are highly concentrated, with limited geographical factors affecting the level of GHG performance (e.g., emission factor of grid power), and already have a large amount of available data for standardised approaches. If there are significant variations in these regards, multiple performance indicators will need to be established at a more disaggregated level (e.g., at each production process of a plant). Therefore, performance standards are likely to be a suitable instrument for large homogeneous sectors. For other sectors where the use of performance comparison is not appropriate, alternative approaches (e.g., use of conservative default parameters) must be considered as fall-back options.

A preliminary assessment of the suitability of standardised approaches to specific sectors is given below (note this is an indicative and not an exhaustive list):

- **The float glass sector** has an extremely limited number of large plants (Visual communication LLC 2008) and a limited number of inputs, which makes it well suited to data collection over a short time period. Moreover, products are standardised and can therefore be more easily compared.
- **Water desalination** has an even more standard set of inputs and output (drinking water) which makes it extremely well suited to standardised approaches based on a performance comparison. Plants are concentrated in a small number of countries.
- Sectors with high complexity but already excellent data coverage and monitoring procedures (e.g., **the aluminium sector**) are excellent candidates for standardised approaches.
- **Appliances** could theoretically present excellent scope for standardised approaches if sufficient data were available at the national level.
- **The cement sector** accounts for 8% of the anthropogenic CO_2 emissions, and produces quite standard outputs (clinker and cement) using similar fuels and processes worldwide. As such it is highly relevant to standardised approaches. The cement sector might however prove more difficult due to a high number of plants of modern commercial scale (probably 3,000 or more), many of which are located in China. Despite the early efforts at data collection and an excellent understanding of the sector, major data gaps remain, especially in China where data availability is low at the plant level.
- Although more concentrated in number of plants, the primary steel sector shows much greater complexity, as different interim products can be consumed and energy exports/imports beyond the system boundaries often have to be considered.

5. Issues related to the implementation of standardised approaches under the CDM

– Summary –

The use of standardised approaches in the CDM is feasible. It will require an improvement in data collection, the early set up of adequate institutions, and the development of specific approaches.

Data collection efforts which could be used by the CDM are already underway. More effort is needed in many sectors to greatly scale up data reporting, requiring an increase in capacity building for those countries with the highest immediate needs. A clearer sector-by-sector assessment of available data and requirements for further data collection is necessary. **The data required for developing standardised approaches is at least partly known for many sectors.** Much experience exists in the private sector as well as in the public sector to support such efforts. Additionally, qualitative data (e.g., on abatement cost and current practices) might be needed in order to derive appropriate performance standards for the additionality and standardised baseline levels. In order to lead the efforts, a properly financed coordinating entity for the establishment of standardised approaches is required. **Investing now in data collection and analysis could save money in the future by helping scale up the CDM potential through standardised approaches.**

Regarding institutional requirements, standardised approaches in the CDM represent a large shift of financial and operational burden from project developers toward public institutions, especially during the set-up phase. **Taking away some of the operational burden and transaction cost is an opportunity for encouraging greater participation of countries currently under-represented under the CDM.** Institutional needs for achieving the key goals of standardised approaches for the CDM are relatively well known. **A Standardised Approach Coordinator (SAC) should initiate a multilateral effort for development of standardised approaches**. It should oversee a set of entities actually calculating performance standards for specific sectors or for specific countries, and coordinate data collection and prepare standardised approaches with their respective performance standards for approval by the CDM EB. A multi-step process with possibilities for stakeholders to interact would help determine the choice of approaches and levels which would then be approved by the CDM EB. Industrial entities and project developers are expected to be the key stakeholders in pushing forward standardised approaches. While their active involvement and collaboration is essential, they should not be able to set standardised approaches by themselves as it is likely that they try to game the system.

A coordinating agency for standardised approaches will need to be established as soon as possible, as any performance standard setting and approval approach is likely to require between one and four years to develop[30]. A preliminary cost estimate of the development of a standardised approach, based on a performance survey covering 200 plants, is €1.2-4.5 million, assuming one-year

[30] See chapters 5.1.2, "Feasibility of data collection", and 5.4.3, "Time horizon", for details of the assumptions.

monitoring for the data collection. If the data already exist, the cost would be €0.2-0.5 million. Upfront financing for institution setting and capacity building as well as standardised approaches feasibility studies is required. The seed funding could be taken from the accumulated surplus of the CDM EB, which has reached about $40 million.

5.1 Data availability

A significant number of methodologies based on performance standards have been prevented or have failed due to limited data availability (see Ch.3.2). Key objectives for data have to be met in order to develop robust performance indicators. Criteria for suitable methodologies have been highlighted by the UNFCCC EB (UNFCCC 2009c). Such criteria include (among others):

- **Quality:** There is sufficient certainty that the data is accurate enough
- **Confidentiality:** There is sufficient certainty that data collected will not impact on competition.
- **Relevance:** The set of data collected contains all data that are required to calculate the performance standard and does not omit important variables[31]. Moreover, the data collected represents a relevant comparison group selected using clear and sensible criteria[32].
- **Completeness:** No important data are missing; the share of production covered is high. Consequently there is high confidence that the data are sufficient to derive accurate enough performance standards.

The availability of data as well as the possibility of gathering further data in order to develop meaningful approaches is a key precondition for the feasibility of any standardised approach. Hence existing data sources must be identified, and the feasibility of further data collection must be assessed. Also, the possibilities opened by existing data sources must be assessed.

5.1.1 Data collection

Due to very different sector characteristics, there is no single way to approach data collection throughout the whole economy. However there is an interest in identifying and capturing the potential for low-cost emission reduction measures through the whole economy. We discuss types of data collections below in terms of their appropriateness for specific sectors:

[31] For example, data should cover all final and intermediary products.
[32] For example, a comparison group for biomass power plants should include countries that have biomass availability, not countries devoid of biomass.

Types of data collections

Bottom-up collection: The bottom-up data collection consists in direct on-site measurements of all relevant installations that produce goods or services which are representative of the expected BaU scenario for the project. The bottom-up collection can be expensive, especially for complex systems in which many inputs have to be assessed. This approach is however the most suitable for many heavily emitting sectors, among which are cement, power generation, aluminium, petroleum and chemicals, power distribution, pulp and paper, glass and water desalination. The bottom-up data collection works best for simple processes showing little differences and with comparable inputs. Standardised approaches relying on a bottom-up collection in the CDM have so far had only limited success. This is mainly due to the lack of willingness of companies to communicate their data to competitors.

Top-down collection: The top-down method relies on a data collection with a very large scope, for example, covering a certain sector. This solution is generally only second best to bottom-up monitoring, as the number of units is too large to monitor them all. The top-down approach relies on extremely aggregated data, often at the national level. For example, in the rail transportation sub-sector, the electricity consumption of single locomotives is not known. The total power consumption from railway transportation is however known on a country basis. By cross-referencing the power consumption with information on the passengers and freight carried, the average electricity consumption per passenger kilometre can be derived. Top-down data collection can be used to derive average consumption or efficiency of the installed capacity. Sectors appropriate for top-down data collection are the building sector (both commercial and residential), transportation, and appliances. Unfortunately, in such sectors retrofits are not common and for CDM projects aggregated data would be required on newly installed units. Countries which monitor the numbers and models of appliances sold, for example, will have a substantial advantage in implementing performance standard-based CDM projects.

Sampling: In the absence of any other measurement type, sampling is used in order to select only similar entities which are seen as representative of what the BAU scenario of the project would have been. Data collection through sampling has already been used in programmatic CDM approaches and appropriate guidance for sampling procedures exists (UNFCCC 2009g). Sampling can be a cornerstone for deriving performance standards in the CDM for distributed measures. However, sampling is generally performed only on demand for a precise project, as it involves the selection of a small sample out of many entities according to specific criteria to match the project (e.g., only a certain type of building of a certain size). Promising sectors for data collection by sampling are the building sector, domestic appliances, and the agriculture sector.

Reporting protocols

In order to facilitate an adequate reporting of emissions by specific sectors, several publicly available reporting protocols have been developed. The efforts led by the WRI have already led to the set-up of reporting protocols for many sectors, including steel, cement, pulp and paper, wood products, lime, ammonia, nitric acid, adipic acid, semiconductors, refrigeration and air conditioning, aluminium and HCFC-22. Additionally, proprietary reporting tools already exist in industries for which a performance comparison of GHG emissions is available from the private sector or from state-led efforts. This is the case with, for example, the petroleum refining sector, whose performance is surveyed by Solomon Associates. Reporting protocols are also available from existing offsetting programmes such as the Alberta Offset Programme, the Chicago Climate Exchange (CCX), CAR and the Climate Leaders Programme (Broekhoff 2007). For sectors without an appropriate reporting protocol, such protocols could easily be designed using elements readily available from the above-mentioned protocols, ISO reporting (Steele 2009) and measurement protocols, and miscellaneous sectoral templates developed by Lawrence Berkeley National Laboratory (LBNL) and/or the Asia Pacific Partnership (APP).

5.1.2 Feasibility of data collection

Sector characteristics

One essential parameter for an appropriate data collection is the sector’s structure, especially the number of entities in the relevant geographic scope. The number of products is also a key characteristic.

Highly concentrated sectors are more amenable to data collection. Such types of concentration are related to (inter alia):

- **The number of companies:** This is the case for example when key players represent a large share of the market (e.g., the ten largest companies represent over 60% of the worldwide production).
- **The number of installations:** A concentration in number of installations offers an extremely favourable condition (e.g., only a limited number of plants need to be surveyed to cover the entirety of the local or worldwide market).
- **Distribution of the production by country:** A sector that is geographically concentrated in a limited number of countries can allow for easier data collection, as key producing countries can agree on setting up a common data collection system.

Regarding the number of plants, the cement sector probably has over 3,000 plants worldwide of an economic scale (excluding small scale production as found in China and India, or dedicated on-site production). With only 220 plants worldwide[33], the

[33] Own estimate based on 123 plants reporting to the IAI (IAI 2009), 90+ smelters located in China and 4% of the worldwide production outside of China non reported.

aluminium sector requires less effort for an appropriate data collection. Collection of data on the steel industry is also seen as manageable. In China, where many small scale steel producing units exist, only 83 plants deliver 80% of the steel output (Duan 2009). With only 260 plants producing 95% of the worldwide output, the float glass industry is also highly concentrated (Visual communication LLC 2008). Many other sectors and sub-sectors have highly concentrated production.

Additionally, sectors with a limited number of technologies, where all units of a certain technology have an almost identical level of performance, can offer simple data collection opportunities. In this case, knowledge of the technology used alone gives precise enough information on the level of performance. Such a sector can be characterised based on technologies.

A guide should be provided to explain to CDM host countries which economic benefits can be enjoyed from the implementation of specific types of monitoring. Consequently, countries could request the capacity building they see as required.

Timeframe and cost

The cost of data collection per installation can vary greatly depending on the sector. The annual average cost of monitoring complex plants (e.g., cement or steel plants) can well exceed €10,000 per plant. Ultimately, the timeframe needed for data collection will depend on the following:

- The existence of an appropriate protocol.
- The reporting and monitoring experience in the sector.
- The efficiency of any organisation supervising or undertaking the data collection effort.

The second key element determining the overall cost of monitoring is the number of installations to be monitored. As previously detailed, highly concentrated sectors are more amenable to data collection.

Depending on the sector, one year is considered a realistic minimum timeframe for any meaningful data collection[34]. However, most data collections are likely to take from one to almost three years, depending on the sector and the selected geographic scope[35]. The cost is expected to vary greatly from simple

[34] The length of time of one year is highly unlikely if no existing data collection is available. The experience with benchmarking in the EU ETS for the ceramic industry has shown that data collection for a sector with limited or no previous data collection and roughly 20 installations was possible in four months. This relies however on a clear mandate to gather data from the EU. As benchmarking is more likely to rely on consensus for the data collection instead of top-down constraint, data collection is expected to take more time.

[35] The time required for meaningful data collection will depend particularly on the complexity of the sector, with the number of inputs and outputs that have to be monitored. While for some sectors the complexity is low, and possibly each plant could collect and report its own data, in more complex sectors specific measurements and pilot periods are likely to be required. Also, experience has shown that data collection in specific countries has been more

sectors with only one or two inputs to monitor, such as water desalination (heat and power inputs), to more complex sectors.

Although the initial level of efforts and costs might be high, the mid and long term benefits of adequate data collection are expected to exceed the cost. For host countries such benefits include the investment channelled into clean technologies and all associated ancillary benefits. For Annex I countries as investors. a major benefit is clearly the possibility of scaling up the CDM, thus decreasing the cost of compliance with the emission cap.

5.1.3 Existing data sources

Private companies performing comparative performance surveys: Worldwide, a limited number of companies offer services in comparing the performance of industrial installations against peers. In the US, Philipp Townsend Associates has carried out over 60 energy efficiency and CO_2 performance surveys for a large variety of sectors and products for companies worldwide (Neelis et al. 2009). Also located in the US, Solomon Associates has proven approaches for comparative performance surveys of refineries. The present coverage reaches more than 80% of refineries worldwide (Solomon 2009) and is well trusted by the industry. Other sectors whose performance is surveyed by Solomon Associates include chemicals, gas, and power. SRI consulting, another US-based company performs comparative performance surveys for the chemical industry. It has developed the “Greenhouse Gases Handbook” for the chemical sector, which includes 100 of the largest GHG emitting processes in the chemical industry (Neelis et al. 2009). This in turn ensures an understanding of GHG emitting processes for well over 90% of the emissions from the chemical industry. It must be noted that SRI also has an in-depth understanding of the economics of chemical processes. SRI has also started working on biofuel producing facilities. In Europe, CIBA expert services as well as Plant Service International (PSI) have strong capacities for performing comparative performance surveys.

In sum, private consultants have already gained strong expertise that can be used for setting up standardised approaches. Independent and skilled comparative performance assessment is already widely available in the private sector.

Industrial associations: Large emitting industries such as the cement industry and the aluminium industry have substantial experience with data collection and reporting efforts as a result of voluntary sustainability initiatives started in the 1990s.

As discussed in Ch. 3.2.2, the 19 company members of the CSI began their efforts with the draft of an agenda for action in 2002 and the publication of a CO_2 accounting and reporting standard in 2003. Over 60% of worldwide cement production outside of

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difficult. Data collections in the steel and cement sectors have both taken over two years and substantial coverage gaps remain.

China was already monitoring and reporting its emissions in 2006 (Vanderborght 2007). Also, the IAI has already engaged its participants for many years in a voluntary agreement to reduce PFC emissions. While the reporting is focused on direct emissions, specific electricity consumption for the smelting of alumina is also well known. The global coverage has reached 64% of the total aluminium production capacity, including 94% of the production capacity outside of China (IAI 2009).

Further, the World Steel Association has also started an important data collection effort on emissions. Manufactured steel products are already very accurately reported by types worldwide, and best available practices have been quantified accurately for most final or interim products of the steel industry, representing well over 90% of the output. Reporting of emissions only started in 2007 and no figure on the coverage has yet been published. In 2008 the World Steel Association represented around 180 of the largest steel producers worldwide with a cumulative output equal to 85% of the world total steel output (Worldsteel 2009).

Industrial associations have so far been the most effective in collecting plant data in databases and in developing key indicators for performance comparison. Sectors with a smaller global scale (e.g., copper production) or with a narrower geographic scope (e.g., water desalination) can also play key roles in data collection. Such sectoral associations should urgently receive support for collecting sufficient data and tracking energy efficiency and GHG emissions.

Internal company data: Globally, much data is already available inside companies. However, such reporting initiatives have so far been done mostly on a voluntary basis by companies primarily located in Annex I countries (e.g., US EPA Climate Leaders Programme).

Data collected from manufacturers of industrial equipment systems would be key to setting up standardised approaches, as both technical performance and cost-related information are available. Most manufacturers of industrial equipment have an obvious interest in the use of such data, as establishing a clear incentive for high performance systems could increase demand for their best performing equipment.

Public institutions: Other sources of data or data collection can be used. For example, in the Netherlands and Flanders, a dedicated institute tracks the energy efficiency of entities participating in the national covenant on standardised approaches.

The International Energy Agency (IEA) tracks energy efficiency levels of many sectors, although on a more aggregated level (IEA 2009). The distribution curve for energy efficiency in the steel sector has shown however that more detailed performance at the plant level might be available, although no information on the completeness of the collection effort is available.

National statistics have so far reported data only at an aggregated level for many sectors, making its use possible only for the average emission intensity of a specific market. Miscellaneous governmental, public, and academic institutions have also been involved in gathering energy and emission-related data, sometimes even with the specific inclusion of qualitative economic information (e.g., LBNL in the US).

Policies, laws and regulations: Substantial research has been undertaken by the EU for large industrial installations to mandate the BAT application. For this purpose, BRefs have been created. Although such documents do not include economic information, they include very detailed information about the most energy efficient and least emitting technology for various sectors. A similar mandate to apply BAT is presently under discussion in the US (US EPA 2009c). Such an effort could enable substantial synergies with the gathering of additional cost-related information. Adding the collection of cost-related information to the gathering of technology related information could generate a set of data very helpful for the choice of performance standards in standardised approaches. This would allow the identification of technologies which are likely to be additional due to their cost or to barriers faced in their implementation.

Emission trading systems: The set-up of the EU ETS especially for phases II and III has led to strong efforts on performance standards for allocation of free allowances for the industries included. The most complete effort on standardised approaches has been led by the UK for phase II of the EU ETS and includes well over 15 industrial sectors with very detailed differentiation by product (Neelis et al. 2009). Other countries making substantial efforts on performance standards include the Netherlands, Denmark and Germany.

Generally, the level of data available from the EU ETS is limited. Emission levels are well known, but product-related information (e.g., production levels) is less readily available. Even insectors forwhich both emissions and product related information are known, the applicability of the information is limited, as the EU has an industrial structure which does not compare to the situations in non-Annex I countries (e.g., age of plants, size, etc.). Moreover, performance standards for emission trading systems have only been developed for direct emissions.

While quantitative information is limited, qualitative information is more readily available. Helpful information on the sectors, their structure, and BAT, is known from work on comparative performance surveys in the EU ETS. A number of studies commissioned by various national governments for phase II of the EU ETS as well as by the EU for phase III of the EU ETS could be used as a starting point to gather information on technologies, efficiency level and related emissions in the different sectors. Although the identification of BAT is helpful, no information on the cost of technologies is available. Thus no baseline or additionality levels can be derived. It should be kept in mind that levels derived levels serve two essential purposes not found in the CDM: (1) to decide on the distribution of the mitigation effort across and among sectors and (2) to protect against possible relocations.

However, the studies supporting the development of standardised approaches provide insight into the approach, data collection and the cost of the effort to establish performance standards.

5.2 Institutional considerations

The performance standard based CDM would shift much of the burden from project developers towards public or industrial sector institutions, and from the operational phase to the set-up phase (Hampton et al. 2008). Thus, a properly detailed roadmap for the set-up phase and for institutional requirements is essential.

All the steps required for the establishment and proper operation of standardised approaches within the CDM require an adequate institutional framework (Egenhofer et al. 2009). Procedures for the operative development of the mechanism, its assessment and approval need to be designed. Numerous entities might be involved in both the set up stage and operation stage of performance standard based CDM approaches. **As conflicts of interest might arise, clearly assigned goals, transparency, and a sufficient separation of powers is needed** in order for such mechanisms to strive in a post-2012 environment.

5.2.1 General objectives

In order to succeed and supply the market with CERs as intended, the performance standard based CDM needs to:

- Have an adequate design in line with its goals, and
- Mobilise further projects.

Any institution in charge of the various steps of the design and operation phases of the performance standard based CDM would have to keep these two key objectives in mind. The first objective is related to successful design while the second is related to successful implementation. Both have so far been concerns of CDM methodologies, as many methodologies have not been able to mobilise a large number of projects, while others are suspected to have failed in eliminating non-additional projects. As there is a trade-off between the two elements, an appropriate balance must be found. In general, the objectives pursued by the performance standard-based offsets are the same as those expressed by the CDM EB (adapted from UNFCCC 2009c):

- **Broad applicability:** The mechanism should be usable by the maximum number of entities for whose use it is intended and cover as high a proportion of their potential emission reductions as possible.
- **Usability:** The mechanism should be able to mobilise a maximum of the potential for emission reductions in an accessible way and to transform them into emission reduction commodities such as CERs.

- **Objectivity:** The mechanism should be predictable and eliminate subjectivity as far as possible.
- **Conservativeness:** One CER should correspond to at least one tonne of emissions avoided compared to the real baseline scenario. This also means that non-additional projects should be eliminated as far as possible.
- **Transparency:** The standardised baseline and additionality levels should be derived in a transparent fashion without resorting to “black box” procedures.

By linking these general objectives of the CDM methodologies with the design and implementation phases, general objectives of the performance standard-based CDM can be summarised in the following table:

Table 4: Quality criteria for standardised approaches in design and implementation phases

Criterion	Design phase		Implementation (use of the methodology by the project developers)
	Design of the approach	Selection of specific levels	
Broad applicability	The approach covers a large share of the abatement potential.	The level allows for the participation of a maximum of installations - the level of disaggregation is suitable.	The applicability conditions are broad enough.
Usability	Input is provided by project developers and industries.	The use of specific projects can ensure the usability.	Appropriate institutions operate the performance standard based CDM.
Objectivity	The approach is developed by an independent consultant. Potential conflicts of interest are disclosed.	The levels are developed based on precise, accurate and neutral sources of information on the sector. Entities proposing the level and approving the level are both neutral.	The mechanism is operated by an independent entity. The database is operated by a neutral entity.
Conservativeness	The approach is checked by a regulatory body.	The levels selected minimise the number of free riders. Companies, countries and regulatory bodies have different interests.	The data set is updated to avoid a loss of stringency.

Transparency	All assumptions are justified. The approach is communicated publicly and available for input.	The assumptions are justified. Sources for the figures derived are provided.	The standardised baseline and additionaltiy levels are published and updates are communicated.

In all steps of the design, the information asymmetry among industries, project developers and countries should be taken into account and minimised. Information asymmetry has proven to be a major problem in the CDM as well as in the design of EU ETS.

5.2.2 Institutional requirements for the implementation of standardised approaches to the CDM

This section summarises institutional requirements at each step in the implementation of a standardised approach. The implementation steps include, among others:

- The set up of a coordinator for standardised approach development.
- The commissioning of an initial feasibility study.
- The development of a standardised approach concept.
- Review and approval of studies for establishing a standardised approach.
- The selection of stringency levels for standardised additionality and baseline.
- Administration of the approved standardised approach.

A clear distinction should be maintained between the design of the standardised approach concept which derives key performance indicators and the decision on stringency levels. Requirements for each are different and might necessitate different types of inputs from different stakeholders.

(1) Set up of a Standardised Approach Coordinator (SAC)

A suitable entity is required in order to ensure adequate, consistent, coordinated and timely implementation of all steps necessary for the development of a standardised approach. Thus, **one single entity – the "Standardised Approach Coordinator" (SAC) – should act as international project manager** for the central, top-down development of standardised approaches, either at the level of one sector across countries or one host country for all sectors or both (Schneider and Cames 2009). Project developers, industries or industrial associations, energy experts and domestic and international CDM regulators would have to be involved at an early stage. In order to be trusted, the SAC needs to be independent.

The non position paper resulting from the Barcelona negotiations in November 2009 mentioned the possible development of standardised approaches by national institutions acting as SACs[36]. This is not recommended for several reasons. Firstly, countries have an economic interest in hosting a maximum of CDM projects, which might lead to biased levels for baseline and additionality, thus undermining the environmental integrity of the mechanism. Secondly, many countries do not have sufficient capacity to act as a SAC, which would restrict standardised approaches to large countries in which more institutional resources are available. On specific sectors, the SAC could in theory also be set at the level of an industrial association. This would however limit the capitalisation of knowledge on standardised approaches across sectors and also result in approaches biased toward maximisation of CERs, perhaps at the expense of environmental integrity.

Ideally, the SAC would be set up as an independent body. For this reason it could be established within an independent international organisation such as the UNFCCC, IEA or others. Within the UNFCCC, the SAC could be either a separate body or a sub-group of an existing body. Due to major differences in concepts and perhaps mindsets of regulators it is not certain that the CDM MP in its present set up would be the most suitable body to act as SAC. If set up as a separate body of the UNFCCC it would be comparable to the CDM MP and supervised by the CDM EB. Another alternative would be to split parts of the CDM MP into a project specific methodology working group and a standardised approach methodology group while sharing some expert staff.

The SAC would oversee a set of entities actually calculating performance standards for specific sectors or specific countries. This second tier of standardised approach developers would work closely with national institutions and relevant industries. Funding for the SAC and the second tier would require a dedicated fund that should be included in the post-2012 climate agreement. Seed funding for the SAC could come from the surplus accumulated by the CDM EB, which amounts to close to $40 million in 2009.

(2) Commissioning a feasibility study

A key task of the SAC would be the commissioning of an initial study to assess the potential for a standardised approach based CDM in different sectors and the identification of specific needs. Such an initial feasibility study should contain the following elements:

- The status of the present data collection.
- Effort and cost needed to reach a sufficient data availability.
- Key features of the sector.
- The level of difficulty expected for designing an approach.
- The difficulties expected in identifying an adequate level for additionality and/or baseline.
- The expected mitigation potential that could be mobilised.

[36] This was not mentioned explicitly in the COP15 outcome in December 2009. However, it could come up again in future negotiations.

As data collection is a critical issue, especially in countries or sectors in which the CDM has until now not been successful, in each feasibility study a detailed and time-tabled action plan on data collection would need to be included, specifying necessary minimum coverage and accuracy for the data to be useful and sufficient. Data collection would require trained and certified energy managers with an in-depth understanding of the sector. Once the inputs for a feasibility study have all been received, it would need to be finalised and published by the SAC.

(3) Development of a concept for a standardised approach

Theoretically, any entity or group of entities or host countries could develop a standardised approach. Regulators such as the CDM EB normally do not have the specific expertise required to develop standardised approaches and derive meaningful performance standards. In our view, the SAC should consist of industry experts and have the aim of developing an objective, applicable and usable approach to the determination of performance standards. The experts hired for standardised approaches should disclose any possible conflicts of interest.

While industries have an excellent knowledge of their processes and sectors, their direct involvement in the development of a standardised approach could be problematic for the following reasons:

- Typically, industrial actors will devise an approach under which they can account for a maximum of emissions of the sector (i.e., optimisation towards broad applicability). In all likelihood the approach will however not be optimised toward usability, conservativeness and objectivity. On objectivity, there is a high risk that the selected approach will not allow for the easiest identification of a straightforward additionality and baseline level that regulators can trust. Instead approaches might be biased toward generating a maximum amount of CERs for a maximum number of eligible projects.
- Specific industrial actors might favour one approach over the other (e.g., a certain type of differentiation) due to the specific conditions of their installations. With high rents at stake and a limited number of stakeholders with diverging views, there is a loss of objectivity.

Host countries would also have an incentive to calculate an overly lax performance standard to maximise CER revenues.

Even if undistorted, unilateral development of standardised approaches under the CDM could repeat the experience with CDM methodologies, where a large share of methodologies face problems on the ground in terms of their implementation. Moreover, time is an important constraint for the implementation of performance standard-based CDM in a post-2012 regime. All activities related to the set-up of the standardised approach need to be coordinated to ensure timely implementation.

(4) Review and approval of studies for establishing a standardised approach

Each study for the establishment of a standardised approach should be reviewed in an open process in order to ensure the five essential criteria are fulfilled. Conservativeness and transparency should be reviewed by the SAC. The key points of usability and applicability should be checked by industries and/or project developers. Also, country-specific applicability should be checked by host countries or at least a group representing host countries in order to take into account their specific needs, expected barriers and ways of overcoming them. This is particularly important for LDCs which have specific needs regarding data collection and capacity building.

Each study for a standardised approach concept should be made publicly available and sufficient time allowed for stakeholders to provide input as necessary. For instance, stakeholders may be asked to provide comments or highlight the need for further detailed studies. In order to remain objective, such further studies should only be commissioned and financed by the SAC upon request from industries and/or project developers.

(5) Selection of stringency levels for additionality and baseline

Experience with the decision process for standardised baseline and additionality levels is already available, through the following: the establishment of multiple performance standards to determine the allocation of free allowances in the EU ETS phase III (Neelis et al. 2009); the decision on specific levels for National Allocation Plans (NAPs) in the EU ETS Phase II; the Marrakech Accords (approach 48.c.); sectoral agreements; and the CDM methodology proposed by the CSI for the cement sector. This experience has shown that decisions on specific levels are political in nature although guided by rational assessments. Where inputs from stakeholders with interests have been possible, attempts to game the system and unrealistic demands regarding both the simplicity of the approach and low stringency levels of the performance standard have been observed.

In the case of the CDM, however, inputs from and collaboration with industry is essential in order to ensure the usability and applicability of the performance standards. A strong institutional framework including dedicated channels for feedback should be established. This should ensure that feedback is used solely for guiding the choice of performance standards by providing appropriate elements to the deciding body. Negotiations should be excluded from the process, as the adequacy of the levels can be tested with appropriate data collection (e.g., plant-specific data with economic indicators to simulate the effect of the standardised approach). In case such information is not available, a more stringent level can be chosen, with an option for it to be revised later on.

Based on the standardised approach set out in the feasibility study, an independent study should be commissioned by the SAC. This is needed to determine the appropriate baseline and/or additionality level, utilising if possible objective technical and economic assessments (e.g., transparent data/assumptions on the cost/benefits of mitigation measures). A precise analysis of the technical and economical parameters in the relevant geographic scope of the standardised approach can greatly enhance the decision on the right levels for additionality and the baseline. These include fuel prices as well as the status of technical equipment and its estimated specific abatement cost. This in turn allows the experts on standardised approaches to simulate ex ante the result of a chosen level for the performance standard. Host countries should be provided with an opportunity to comment. A sensitivity analysis for variation of the standardised baseline and additionality levels should be included.

Final approval of each performance standard should be done by the CDM EB on the basis of a recommendation by the SAC. This would mirror the current process for CDM methodologies. Approval should specify the date when the performance standard would have to be updated. Project developers could use the performance standard from the date of its approval.

Overall, the development and approval phase of the standardised approach could take place according to the following flow chart (Figure 10). The procedure encompasses the development of the approach, its review and approval, the choice of levels for additionality and baseline as well as all interrelated efforts on data collection[37].

[37] If procedures are established differently, a different chart flow would result. This could be the case if further elements are pooled, in case of a simplified approval process for benchmarks.

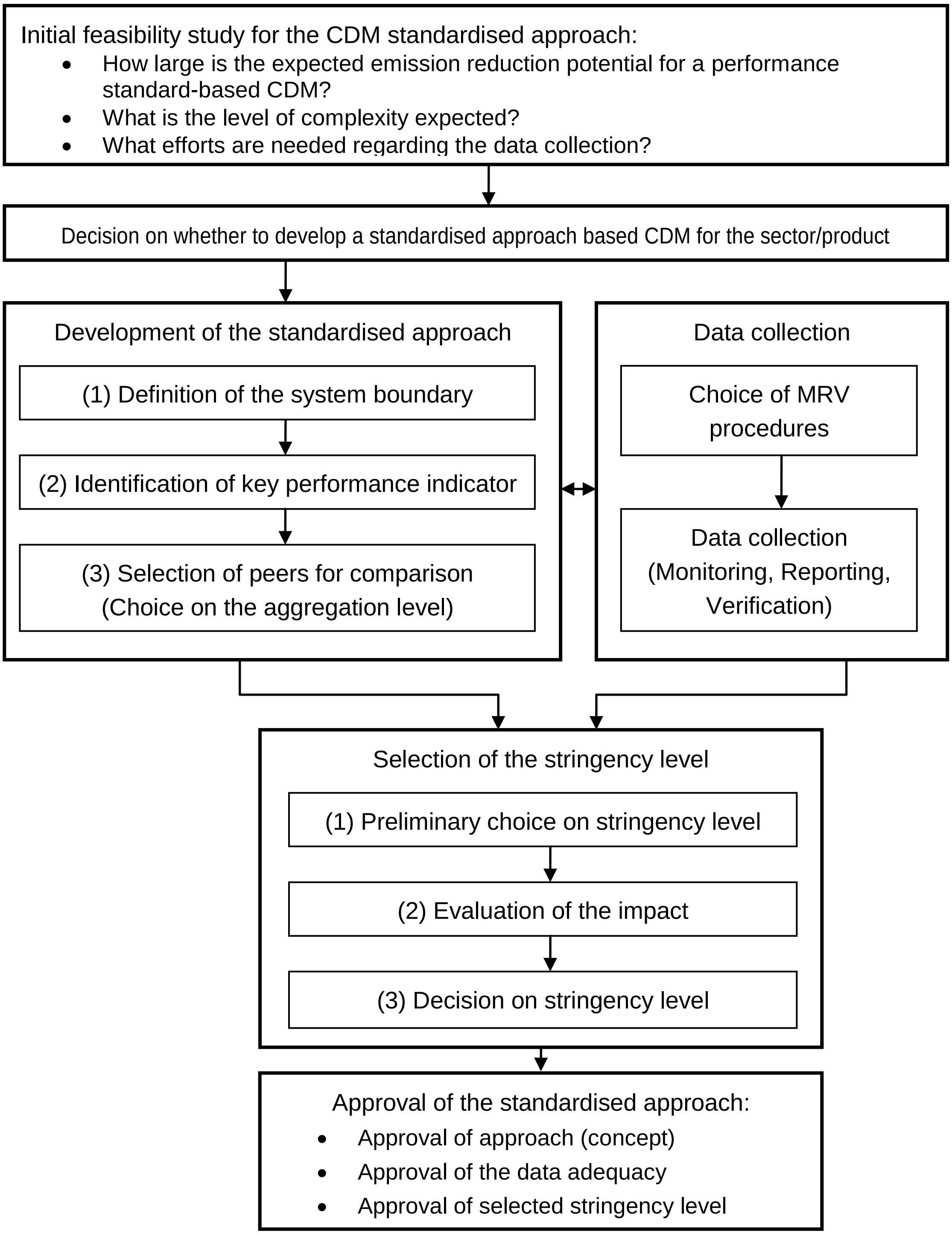

Figure 10: Flow chart of standardised approach development and approval process

(6) Administration of approved standardised approach

The SAC would administer a database of approved standardised approaches with their specific levels, including their expiry dates. In case of problems with the use of a performance standard or the whole approach, the SAC could start a revision process. Revisions would have to go through the different steps of the procedure outlined above.

5.3 Monitoring, reporting, verification of data

Monitoring: In addition to the need for a reporting protocol, the monitoring itself should be performed according to a recognised procedure that is trusted and accurate enough for the desired purpose. Therefore each approved standardised approach should include a reporting protocol and a standardised set of monitoring and reporting guidelines and/or guidance[38].

Reporting: Data reporting should be performed in a standardised manner and each approved standardised approach should include a reporting protocol. Such protocols are not expected to be a major concern as they should follow the selected standardised approach. Additional data beyond the present need of the performance standard should be included for future needs. Successful reporting protocols have already been developed by institutions such as the US DOE-LBNL, the WRI, and private companies (Broekhoff 2007). Also, the industry has a sufficient level of knowledge to develop its own reporting protocols. In the feasibility study on the standardised approach, reporting protocols should be tested on the ground in order to (1) ensure the feasibility of gathering adequate information, (2) ensure the feasibility of data collection with regard to country data collection practices, and (3) assess further needs. Additional guidance might be required in order to detail how the reporting protocol should be used and what should be monitored.

Verification: DOEs are appropriate for verifying the monitoring of data collected. The data to be verified will include specific data from the project developer as well as data from peers used to calculate the performance standard published by the SAC. The former would be akin to validation of the baseline grid emissions factors published by a DNA. In the case of a large number of entities, as in the cement sector, not all plant data would need to be verified as a limited number of errors would not severely impact the specific levels selected for baseline and additionality and could be tolerated. A review procedure should be put in place in order to identify data which appear to be unrealistic. Only entities implementing a project would require an in-depth verification process in order to prevent gaming. For other entities from which data are derived but which do not implement a project, the verification of a limited sample of data is sufficient.

Overall, the requirements for monitoring, reporting and verification (MRV) will depend on the sector. In sectors with a large number of entities, less stringent MRV is

[38] The CSI in particular has provided guidance for the cement CO_2 reporting protocol (CSI 2005 and 2009). Specific information on monitoring and measurement can be found in the various ISO working groups. Substantial efforts to measure energy efficiency and CO_2 are already underway (Steele 2009). Depending on the sector/product, the monitoring procedure might need to be simplified in order to be useable for a benchmarking based CDM.

possible as the opportunities for gaming by a single entity are limited. A data gap can even be acceptable provided that there is a high enough level of confidence that the missing installations will not influence aggregated levels in a meaningful way and reduce the conservativeness. For example, in countries such as China and India, data on small-scale installations might not be needed. However, in sectors with a limited number of entities (e.g., 10 or less) gaming is possible. In this case a lack of accuracy in reporting can influence the baseline and additionality level to a meaningful degree. Accurate MRV will still be needed at all plants implementing CDM projects in order to determine the additionality accurately and to calculate the right amount of CERs. Overall MRV requirements are expected to be equal to or lower than those under the project-by-project CDM on an installation level. However, a much larger number of plants might need to be surveyed, resulting in much greater overall effort. Synergies are expected to be found with other data collection efforts, whether for other climate mechanisms or for different purposes.

5.4 Challenges in the implementation of standardised approaches

Many challenges remain in the implementation of standardised approaches for the CDM. Beyond the institutional set-up, the upfront investment and data collection effort required are the main challenges. Another major challenge is the time horizon for the calculation of performance standards.

5.4.1 Lack of incentive for participation in data collection

Without a clear communication of the expected benefits and a realistic chance to reap those benefits, there is only a limited incentive for host countries to implement the necessary data collection for establishing a performance standard. For example, some industries are largely dominated by either one or a limited number of countries. Thus, without a pledge by developing countries of free access to data for regulators, projects in developing countries would not benefit from a standardised approach. This is the case for example in the magnesium industry, which is found almost exclusively in China and for which no data other than aggregated sectoral data is available.

The willingness of potential host countries to collect and submit plant specific data is limited as this process is seen as (1) a burden, if there is no appropriate support for capacity building and financing, and (2) a stepping stone to future emission reduction commitments.

The experience with the calculation of electricity grid emission factors has shown a lack of willingness on the part of DNAs to have their data and fact collection work verified by a third party. This is presumably because the data were biased towards an overly high level and because data collection gaps existed (Point Carbon 2009c). In turn, there is a perceived risk of rejection of DNAs' figures related to gaps in data collection and MRV practices. Additionally, third party verification can be perceived as an additional cost or even an infringement of sovereignty, as shown by the difficulties in Copenhagen with negotiating verification of nationally appropriate mitigation actions (NAMAs).

There is a split incentive in which the benefits from a robust data collection for standardised approaches can be global (i.e., the benefits accrue to all countries) while the burden of data monitoring, reporting and verification is perceived as local. **Thus international financing must be provided to overcome these obstacles.** Countries should agree with the SAC to collaborate on data collection if the full costs of data collection are covered by international funding and the confidentiality of plant specific data is ensured.

5.4.2 Organisation of the sector

The degree to which a sector is structured is a key factor in the success of standardised approaches. While a structured sector provides an opportunity to gather data more easily and have key partners in negotiations, sectors which are not consolidated in key companies and plants, and/ or key producing countries, represent a challenge. In particular sectors without a strong, pro-active, well-organised sectoral association would face barriers in the collection, exchange and spread of key information.

5.4.3 Time horizon

The minimum amount of time expected to be required for the development and approval of standardised approaches is roughly one to four years (including data collection), depending the complexity of the sector and the availability of existing elements such as recent market studies, monitoring protocols, data collection efforts, MAC studies, etc.[39] For example, the CSI took the first steps toward a standardised approach in 2002, leading to the development of a CDM methodology still under review by the CDM MP in 2009 (UNFCCC 2009h). **For this reason, any work should be started as early as possible, beginning with the set-up of the SAC.** For sectors already well examined by enough experts, work on both data collection and definition of the standardised approach could be undertaken in parallel, allowing

[39] Data collection is often expected to be the most time-consuming step when setting up a complete benchmarking CDM for a specific sector, as explained in the footnotes in chapter 5.1.2. However, the development of a benchmarking procedure (excluding decisions on specific levels and data collection) could be performed in some cases in only six months (as shown by the experience with the many benchmarking studies commissioned by DEFRA within the frame of the NAPs for the EU ETS Phase II). The choice of specific levels for the stringency of benchmarks is expected to take at least a couple of months if it is to be reviewed in depth, as is the case with CDM methodologies. Sectors with a very simple structure such as water desalination could probably be managed in slightly less than two years if no additional time is required for the political process.

for short deadlines in the development of an approach and decisions on specific baseline and additionality levels.

5.4.4 Funding needs

As discussed above, neither project developers nor host countries are willing to provide upfront funding for the establishment of standardised approaches. Capacity building at the country or sector level is necessary in order to enable data collection. Even if data exist, work on harmonisation of the collected data might be required as countries will have different sector definitions.

The development of a standardised approach is expected to cost between €0.2-0.5 million (excluding monitoring costs) depending on the complexity of the sector. The number of variables to take into account and the complexity in determining baseline levels and additionality levels are key determinants of total cost. Additionally, we assume that the annual average monitoring cost would likely range from less than €5,000 to over €20,000 per plant depending on the complexity of the processes and the selected approach (especially the extent of data aggregation).

A rough estimate of total costs for the development of a standardised approach covering 200 plants would be €1.2-4.5 million, assuming one-year monitoring for the data collection. If the data already exist, the development of the standardised approach itself would cost €0.2-0.5 million. The initial cost of developing a standardised approach is not expected to decrease significantly over time, as each sector is specific. On the other hand, expanding the standardised approach to other countries or regions, once an approach is available, is expected to cost much less than the initial development.

The operation of the standardised approach is expected to cost only a fraction of the cost of the setup phase. The largest cost for operating the standardised approach relates to updating the data collection. Updates of the dataset are however expected to cost far less than the initial monitoring as less economic information is required and MRV procedures and the necessary monitoring equipment will already be in place.

5.4.5 Data management

Data management is a key point of any monitoring, reporting and verification system. Data ownership and use are the most sensitive of all issues, whether it is countries or companies participating in the performance comparison survey.

Queries for data should in most cases be controlled by experts, as a small number of plants in a query could possibly allow a back calculation of plant specific-performance levels, potentially releasing key company or plant information to their competitors. Consequently, entirely automated data queries in electronic form should be avoided. In some cases, countries might even refuse third parties' access to their own data.

Data ownership and management of confidentiality should be granted to the SAC as it is for the CSI's GNR database (CSI 2009). Disclosure of possible conflicts of interest should be mandatory for all entities and people receiving access to such data. In the case of highly competitive industrial sectors, data is a very sensitive issue, especially if economic parameters are included. For this reason, any approach should ensure maximum security against electronic data theft.

Data management includes many tasks related to queries, reporting aggregated indicators and updating the dataset. For this reason, data should be managed by specialists with sufficient expertise in identifying and reporting erroneous data. A specific procedure for data rejection and correction should be included in order to deal with such cases.

6. Implications of the greater use of standardised approaches

– Summary –

The implications of adopting a standardised approach to the CDM are assessed on the following four criteria: environmental effectiveness, cost effectiveness, distributional considerations, and institutional feasibility.

Environmental effectiveness

Standardised approaches are likely to mobilise a broader coverage of mitigation measures. However, a wider investment choice does not necessarily accelerate the scale of real and additional emission reductions. The more stringent a performance standard is, the more likely that non-additional projects are weeded out, but at the same time less projects will be able to beat the performance standard. **Setting the "right" level of stringency requires a high degree of confidence in the efficiency or carbon intensity distribution curves of BAU projects.** Where this is not possible, alternative approaches need to be pursued. Project-specific additionality tests or credit discounting could be options.

While regularly updated performance standards can provide ongoing incentives for technology innovation, frequent updates increase transaction costs. Therefore, **a clear procedure for updating performance standards will need to be agreed upon at the outset.** In order to reduce transaction costs, the update could be done on the basis of a default improvement factor.

Standardised approaches would need to work with policies, rather than trying to establish baselines without policy effects. Performance standards could be established based on the performance of numerous installations in different regions, which may make it difficult to weed out the impacts of relevant policies. One way to address this issue is to choose a more ambitious level for the performance standard, which would minimise the risk of crediting policies that would have been adopted anyway.

A stringent performance standard is required to ensure environmental integrity, but an ambitious performance standard may not provide sufficient incentives to existing, less efficient installations. In order to address this issue, one could either determine the baseline on a project-by-project basis, or set performance standards differentiated by new and existing installations, and possibly even by vintage classes.

Cost effectiveness

The number of performance standards has a decisive impact on cost-effectiveness; a high degree of disaggregation leads to high costs. An important trade-off exists between the simplicity and the stronger investment incentives for low-carbon technologies provided by a single performance standard, and the opportunities for performance improvement by high-carbon technologies provided by performance standards differentiated by technology.

In our view, **performance standards should be set in a product or service-specific, technology-neutral manner.** However, as discussed above, the

differentiation of performance standards between new and existing installation, and possibly by vintage class, is necessary to provide sufficient incentives for improvement by existing installations.

Distributional considerations

If a standardised approach becomes a voluntary option, project developers would have a choice between a presumably stringent performance standard and a project-based baseline. This would provide positive incentives for exploring new CDM opportunities, leading to an improved distribution of CDM projects. A mandatory standardised approach could reduce the CER potential as performance standards are likely to be set more stringently than in BAU scenarios.

More specific to geographical distribution, the shift of the burden of baseline development and additionality determination from project developers to a dedicated body, as well as standardisation of those approaches, would **likely encourage participation by underrepresented countries, e.g., LDCs.** However, installations in these countries are typically less efficient in emissions performance. Setting performance standards without taking into account the local conditions of these countries would likely result in an unfair distribution of projects. **Sector and project-size distributions can be improved if fall-back options to determine performance standards** (e.g., default parameters for the baseline setting) **can be made widely available**.

Institutional feasibility

The setting of the performance standards requires detailed and recent data that are not available in many CDM host countries. **The capacity to monitor, report and verify emissions and activity data for the relevant sector and its installations needs to be developed and supported by financial and technical assistance.**

Given that the CDM only issues CERs ex post, there will be a financing gap between the establishment of the domestic institutional capacity and the revenues from potential CERs. In order to support the necessary capacity building activities, support should be given to host countries in the form of technical assistance and funding. Besides the possible financial support from the surplus of the CDM EB, multilateral or unilateral support programmes could be established to increase institutional feasibility.

This section analyses the implications of a greater use of standardised approaches under the CDM. They are discussed according to the four principal criteria for evaluating environmental policy instruments: (1) environmental effectiveness, (2) cost-effectiveness, (3) distributional considerations, and (4) institutional feasibility (Gupta et al. 2007)[40].

[40] Gupta et al. (2007) identify these as the four principal criteria for evaluating environmental policy instruments: (1) the extent to which a policy meets its intended environmental objective or realises positive environmental outcomes, (2) the extent to which the policy can achieve its objectives at a minimum cost to society, (3) the incidence or distributional consequences of a policy, which includes dimensions such as fairness and equity, among others, and (4) the extent to which a policy instrument is likely to be viewed as legitimate, gain acceptance, and be adopted and implemented.

6.1 Environmental effectiveness

There are many issues to consider in assessing the environmental effectiveness of the standardised approach. In the following, we analyse selected issues that we believe are important for the environmental effectiveness of the CDM. These are: scale of real and additional emission reductions, information asymmetry, incentives for technology innovation, consideration of policies in baseline setting, and incentives for the worst-performing emitters.

6.1.1 Scale of real and additional emission reductions

The environmental effectiveness of standardised approaches can be assessed by the scale of "real and additional" emission reductions that the CDM could mobilise. It is arguably true that standardised approaches would enable the implementation of a broader coverage of mitigation measures, even including soft measures such as operational improvement by good housekeeping[41]. Therefore, the approach would provide project developers with **a more flexible investment choice in mitigation measures**.

However, the wider investment choice does not necessarily mean that standardised approaches would further mobilise real and additional emission reductions. **An important methodological issue here is the stringency of performance standards.** The higher the stringency, the more likely it is that non-additional CDM projects would be weeded out. However, the overall amount of real and additional emission reductions does not increase proportionally with the stringency of the performance standard. As the number of projects that can beat the performance standard would fall, so overall reductions would also fall. Figure 11 shows this trade-off.

[41] However, soft measures have never been allowed for claim of CERs under the CDM.

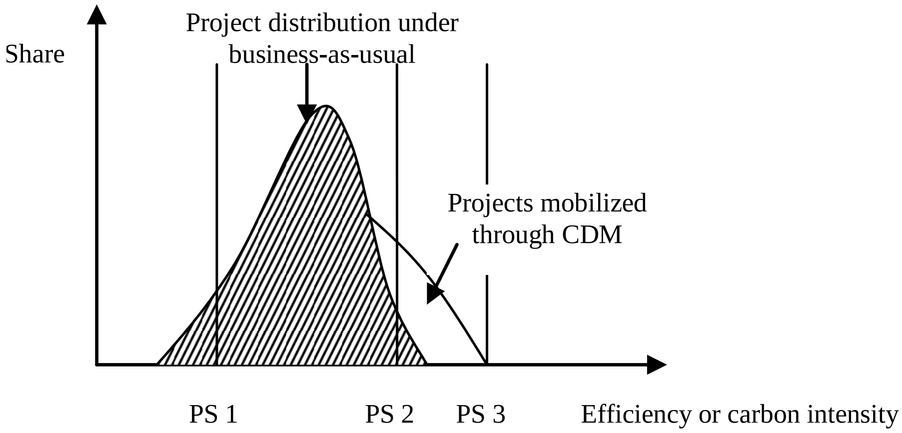

Figure 11: Impact of performance standard choice on additionality of CERs and project volumes

Note: PS denotes performance standard. The figure assumes that efficiencies/carbon intensities of new BAU projects (non-additional projects) are distributed in the shaded area. Projects that could be mobilised only through the CDM (additional projects) are shown in the non-shaded area. Any projects to the right of the performance standard level would be credited. PS 1 generates a lot of non-additional reductions, as most BAU projects are eligible. PS 2 balances non-additional CERs with non-crediting of real reductions. PS 3 is too strict, as it does not mobilise any projects.

If any emission reductions beyond the performance standard level were to be credited automatically, the performance standard determination would require a high degree of confidence in the efficiency or carbon intensity distribution curves of BAU projects for all technologies and countries, and all vintages. This is not always possible under real-life conditions. Therefore, alternative approaches may need to be pursued for sectors in which the “right” level of performance standard cannot be determined with high certainty. Lazarus et al. (2000) proposed two alternative approaches for minimising the risk of non-additional credits: (1) project-specific additionality tests, and (2) credit discounting.

Project-specific additionality tests could be performed to ensure environmental integrity. However, as the CDM experience to date has shown, testing additionality of every single project would not reduce the complexity and transaction costs of the mechanism. For this reason, Lazarus et al. (2000) suggest additionality testing be accompanied by project screens, which could be applied to: a) limit additionality tests to only those project types with the highest risk of questionable credits (e.g., projects with already significant market penetration), or b) automatically exclude activities that are considered likely to be non-additional in a given context (e.g., large hydro in countries with low-cost sites). If a performance standard is set at a reasonably stringent level, the simplification of the additionality tests may be justified.

Credit discounting could – on an aggregated level – be used to scale down the number of credits by a factor based on the likelihood of non-additionality. For example, Schneider (2007) categorises CDM projects into three groups according to the typical impact of CERs on their economic attractiveness. Discount factors could be set lower for a project group for whom CERs form a large part of the economic attractiveness of a project (group 1), and higher for a project group where CERs have a smaller impact (group 3):

- Group 1: Projects with significant benefits from CERs (e.g., HFC23, N_2O, CH_4 destruction).
- Group 2: Project with economic benefits other than CERs and considerable CER impact (e.g., recovery and utilisation of CH_4).
- Group 3: Projects with other economic benefits than CERs and small CER impact (e.g., renewable energy, energy efficiency, fuel switch).

Lazarus et al. (2000) argue that credit discounting is inherently no more complex than assessing the right level of performance standard stringency or project-specific additionality testing because it simply involves using some judgement to set thresholds or categories for discounting.

A more concrete conclusion on performance standard stringency cannot be made, as this depends on the characteristics of each sector. Before performance standards are used for additionality testing, the characteristics of the project distribution curves need to be known with a high degree of confidence. Unless credible distribution curves are determined by institutions that are not lobbyists for certain industries, alternative approaches would be required to safeguard environmental integrity. **Simplified additionality testing and/or CER discounting could be options for such an alternative approach.**

6.1.2 Information asymmetry

Related to performance standard stringency, asymmetric information is also an issue that needs careful consideration when implementing standardised approaches. As we have experienced with the CDM so far, especially with the additionality testing of CDM projects, there is a fundamental asymmetry of information between project developers and CDM regulators. As discussed in Ch. 5.2.2, industries typically have better knowledge of their BAU scenarios and try to reap the maximum amount of emission reductions by over-inflating the baselines. The problem of information asymmetry would likely be a much greater concern for standardised approaches because a sector consists of numerous entities each seeking to shape the performance standard in their favour.

In order to alleviate this inherent problem, it is important to have independent industry experts to establish performance standards. The performance standards should be reviewed in an open process, making all the relevant information publicly available and ensuring sufficient time for consultation with stakeholders. The final approval of performance standards should be made by the CDM EB.

6.1.3 Incentives for technology innovation

Standardised approaches, if updated at appropriate time intervals, could provide a permanent incentive for technology innovation because the updated performance standard takes into account more recent developments in technology (Hampton et al. 2008). However, frequent update of performance standards would be burdensome, so **the frequency of updating has to be balanced against its transaction costs.**

A concern is that performance standards, once set, may suffer from inertia effects. As the upfront effort for setting performance standards is so high, stakeholders might insist on keeping the set level for a time period long enough to avoid incurring additional transaction costs.

In order to alleviate this possible resistance and provide the right incentives for technology innovation, **a clear procedure for updating performance standards has to be agreed upon at the outset.** Instead of collecting performance standards data, one could also use a default improvement factor for updating a performance standard. A conservative default improvement factor could reduce transaction costs.

6.1.4 Consideration of policies in baseline setting

As a general principle of the current CDM, national and/or sectoral policies and circumstances are to be taken into account in the establishment of baseline scenarios, without creating perverse incentives that may impact a host country's contributions to the ultimate objective of the UNFCCC (UNFCCC 2005). This is commonly known as the E+/E- rule.

With a standardised approach, however, policy effects are very difficult to exclude from baseline establishment. Performance standards are established based on the performance of a number of peer installations. The assessment of a counterfactual scenario for every single installation gets extremely complicated, especially if the performance standard is to be established using a large geographical boundary (e.g., global performance comparison). Furthermore, most policies have several motivations which cannot be clearly distinguished. A key lesson learned from the current CDM is that demonstrating motivation is subjective and arbitrary. This applies, in particular, to decisions of policy makers, which depend on many factors (Schneider and Cames 2009).

Given the inherent challenge of the consideration of policies when setting baselines, it has been argued that **the CDM will have to work with domestic policies, rather than ignoring them, in order to enable policy co-financing** (Hampton et al. 2008). One way to address this issue is to choose a more ambitious performance standard level that could "on average" avoid crediting policies that would have been adopted anyway (Schneider and Cames 2009).

6.1.5 Incentives for the worst-performing emitters

A peculiar concern of the standardised approach is that the adoption of a stringent performance standard would not incentivise the worst-performing emitters that lag far behind the performance standard level. If the performance standard approach were a voluntary option for project developers, the baselines of the worst-performing emitters could be established on a project-by-project basis.

An alternative approach, which could also work with a mandatory standardised approach, is to **set differentiated performance standards for new and existing installations or even differentiate performance standards by vintages of existing installations.** Such differentiated treatment for existing installations is justified in many cases by their high capital costs of upgrading or long lifetime of capital stock. For instance, there is already a de-facto approach of differentiating the procedures for initial allocation of allowances between new and existing installations in the EU ETS (Hampton et al. 2008).

Setting a different performance standard for existing installations could be politically complex as it is most likely the case that installations performing below the performance standard level would try to lower the performance standard level for their own benefit. This is always the case with standardised approaches whether the single or differentiated approach for the establishment of a performance standard is taken. However, the latter approach would simply multiply the political complexity of setting performance standards.

An important technical issue for setting a different performance standard for existing installations is the remaining technical lifetime of these installations. Some installations in a sector may have operated for a long time and already be close to the end of their technical lifetimes. Since they would be shut down soon anyway, they should not have equal weight with other installations in determining the performance standard level for existing installations. A simple approach would be to exclude installations close to the end of their technical lifetimes from the process of setting the performance standard. The assessment of technical lifetime is challenging, but one could build on the methodological tool recently approved by the CDM EB: “Tool to determine the remaining lifetime of equipment” (UNFCCC 2009f).

6.2 Cost-effectiveness

It is often argued that standardised approaches could potentially increase the efficiency of the CDM. Namely, standardised approaches based on a performance standard are seen as low-cost, predictable instruments (Lazarus et al. 2000, Ellis 2000, Winkler et al. 2001). Though the increased predictability is a reasonable expectation, the low-cost argument requires further consideration. In general, it is assumed that standardised approaches lower the transaction costs associated with baseline setting and additionality demonstration. However, this is not necessarily the case. The more input parameters that are considered in the development of standardised approaches, the higher the transaction costs become (Michaelowa et al. 2008). An important technical aspect that determines the cost-effectiveness of a standardised approach is the number of performance standards.

A single sector-wide performance standard may provide no incentive for CDM projects that improve the efficiency of relatively carbon-intensive options. Therefore, it is argued that performance standards should be developed by technology type in order to give opportunities to improve the performance of high-carbon fuels and technologies as well (Lazarus et al. 2000). On the other hand, the typical engineering bias towards multiple technology-specific performance standards would entail a high transaction cost. Further, a single sector-wide performance standard would provide a strong incentive to invest in low-carbon technologies and provide incentives for project developers to select the most cost-effective mitigation options available. Therefore, others argue that no differentiation of performance standards should be necessary (Winkler et al. 2001, Hampton et al. 2008, Neelis et al. 2009). Therefore, an important trade-off exists between the simplicity and stronger investment incentives for low-carbon technologies given by a single performance standard, and the opportunities for performance improvement by high-carbon technologies provided by performance standards differentiated by technology.

In principle, performance standards should be established on **a product or service-specific basis**, as has been done in existing CDM methodologies and other initiatives to establish standardised approaches. We also argue that **no differentiation should be made as to technology types** in order to give a clear signal for a low-carbon development path. But we consider it is important to **distinguish new and existing installations.** If a single – and presumably stringent – performance standard is set for a sector regardless of the vintage or age of the installations covered, it would not be able to give the worst emitters incentives for performance improvement. Therefore, it is important to distinguish performance standards levels for new and existing installations, and possibly even differentiate them according to vintage classes.

6.3 Distributional considerations

Whether basing the CDM on a standardised approach would improve the distribution of CDM projects is a challenging question. Among the very few existing studies that aim to quantify the impacts of the new mechanism on the CER supply, Point Carbon (2009b) provides a good basis for starting the discussion of distributional considerations.

The Point Carbon study concludes that, as compared to the scenario that assumes the continuation of the current project-based CDM, the CDM based on a standardised approach could lead to increased cumulative emission reductions on the order of six percent for the period of 2013-2020 (530 million tCO_2)[42]. Based on the assumption that the use of performance standards would not become mandatory, but rather be a voluntary option for project developers, enhanced mitigation efforts are expected for the following reasons:

- Processing time for project registration by the CDM EB would be reduced,
- More projects would be approved because the terms for approval would be more transparent and predictable, and
- More projects would apply for CDM registration because transaction costs would be reduced.

Further, they assume that standardised approaches would be widely applied to projects that are streamlined and relatively easy to compare, such as renewable energy and energy efficiency projects. On the other hand, it is assumed that standardised approaches would be used to a very limited extent for HFC-23, landfill and coal mine CH_4 projects, as projects in these categories are very different from each other, so it is difficult to establish performance standards for them. Given the above, the model simulation results in an increase in emission reductions from renewable energy and energy efficiency projects.

The key issues affecting distribution of projects tend to fall into two groups: regulatory and technical. Regulatory issues – whether the standardised approach is voluntary or mandatory – are common to all three aspects of distributional impacts: sectoral, geographical, and project size. Therefore, this issue is discussed first before we analyse the details of the technical aspects.

As discussed in Ch. 0, international climate negotiations have yet to agree on whether standardised approaches shall be a mandatory or voluntary instrument. If they are used on a voluntary basis and the performance standards are sufficiently stringent to guarantee additionality, standardised approaches would likely lead to increased emission reductions and potentially improve any or all of the three distributional aspects. This is because project developers would be free to use performance standards for exploring new opportunities in currently underrepresented

[42] However, note that not all the incremental emission reductions might be real and additional, as discussed in the environmental effectiveness section.

project categories. But they would not be forced to use the presumably more stringent baselines for project categories where they could easily make use of current project-based baselines. Voluntary standardised approaches would only provide carrots to project developers. **On the other hand, if they became mandatory, they could drastically reduce the number of projects if the stringency level is set unreasonably high** (Point Carbon 2009b). Therefore, the regulatory nature of standardised approaches would likely have an important impact on CDM project distribution.

If standardised approaches were to become a voluntary option, voluntary standardised approaches should in principle generate fewer CERs for a project than the project would receive when applying a project-specific baseline. This would mean that the opt-out from the standardised approach would not always be attractive for the project developer, who will assess whether the reduction in transaction costs is larger than the revenue loss through lower CER generation and decide accordingly.

6.3.1 Geographical distribution

As shown in Ch. 2.1.1, LDCs, including many African countries, have only a minor share of the CDM pie. So a key question is whether standardised approaches would help increase the number of CDM projects in these countries. In general, the shift of the burden from project developers to a dedicated body, as well as standardisation of the baseline and additionality procedures, would likely **encourage greater participation by LDCs.**

It should be noted, however, that installations in LDCs are likely to be less efficient than ones in more advanced developing countries (there are, of course, exceptions). Therefore, they would most likely not benefit from a single global performance standard. **If no country or region-specific circumstances are taken into account for the establishment of performance standards, rather unfair distributional effects might result** (Michaelowa et al. 2008).

Differentiation among the group of developing countries is politically very sensitive and difficult to negotiate. The only existing differentiation under UNFCCC among non-Annex I countries in terms of development level is the classification of LDCs. In this regard, the differentiated treatment of LDCs might be justifiable but would require careful negotiation.

6.3.2 Sectoral distribution

A technical issue that is critical for sectoral distribution relates to sector characteristics. In general, sectors amenable to standardised approaches produce goods or services similar in their nature and production processes. Also, sectors producing many co-products are difficult to assess with regard to their comparative performance as emissions have to be apportioned to the different co-products. Ideal sectors would be highly concentrated, with limited geographical factors affecting the level of GHG performance (e.g., grid emission factors), and already have a large amount of data available for standardised approaches. If there are significant variations in these characteristics, multiple performance standards have to be established at a more disaggregated level (e.g., at each production process of a plant). Therefore, standardised approaches are likely to be a more suitable instrument for large, homogeneous sectors. For other sectors, where standardised approaches are likely to be much harder, alternative fall-back approaches (e.g., use of conservative values in the baseline emission calculation) should be considered (Butzengeiger-Geyer et al. 2009).

The currently underrepresented sectors are smaller and more heterogeneous (e.g., demand-side energy efficiency, transport) (see Ch. 2.1.2). Consequently, the success of the new mechanism in these sectors would play a decisive role in broadening sectoral distribution. Therefore, **it is important to consider using fall-back approaches in case standardised approaches are not deemed feasible.** The use of fall-back approaches is also being considered in the preparation for phase III of the EU ETS (Ecofys/Fraunhofer ISI/Öko-Institut 2009a). It should be noted that such fall-back approaches are not limited to the standardised approaches of performance comparison; they can also be used under the current CDM.

With the use of fall-back approaches, the CDM based on a standardised approach could improve sectoral distribution. Otherwise, the potential of standardised approaches would likely be limited to the sectors that have already received the most benefit from the CDM.

6.3.3 Project-size distribution

The analysis in Ch. 2.1.3 showed that micro-scale CDM projects have not yet been mobilised on a large scale. In general, sectors with small and dispersed emission sources are very difficult to assess under a standardised approach due to the high transaction costs associated with data collection. As a result, **the impact on project-size distribution largely depends on whether, as a fall-back option, default values for the calculation of emission reductions could be used.** This would be needed in order to scale up the potential of micro-scale CDM projects.

Note, however, that there is already a PoA framework introduced into the CDM in order to mobilise micro to small-scale projects. If the programmatic CDM can use performance standards, its attractiveness might further increase.

6.4 Institutional feasibility

Standardised approaches will not be widely adopted as an approach without host countries' ability to set up, either independently or with external assistance and surveillance, meaningful performance standards (Hampton et al. 2008). **Of paramount importance is the existence of background data at sectoral and installation levels on emission levels, factors and production data.** Given the sensitive nature of much of this information, it is likely that a central, independent body would be tasked with the collection and storage of such information (Hampton et al. 2008). Otherwise, gaming could become an important institutional barrier, and the transparency of the mechanism would be jeopardised (Michaelowa et al. 2008).

Furthermore, the capacity to monitor, report and verify emissions and activity data for the relevant sector and its installations needs to be developed. This requires the establishment of customised monitoring, reporting and verification protocols (Hampton et al. 2008). Monitoring of GHG emissions from most industrial sectors has greatly improved under existing standardised approaches initiatives (e.g., EU ETS, offset mechanisms in the U.S., and international initiatives like the CSI and IAI). However, the analysis in Ch. 3.2 revealed that the approaches are not yet harmonised or rigorous enough – probably with the exceptions of the IAI and CSI protocols – and hence not yet ready for application to the CDM.

Given that the CDM only issues CERs ex post, there will be a financing gap between the establishment of domestic institutional capacity and revenues from potential CERs. **In order to support the necessary capacity building activities, the required support should be given to host countries in the form of technical assistance and funding.** For instance, the World Bank, through its new initiative called the Carbon Partnership Facility (CPF), promotes grants and technical assistance to establish the domestic policy framework required to facilitate carbon finance programmes on a larger scale (Aasrud et al. 2009). Similar multilateral or unilateral support programmes could be established to increase the institutional feasibility of the new mechanism.

7. Case study I: Whole-building efficiency improvement

– Summary –

Despite their high technical potential, methodological and organisational barriers have hindered the uptake of building efficiency projects under the CDM. The interaction of building efficiency measures makes it difficult to establish a clear causality between the measure and the resulting emission reductions, which has been the fundamental requirement for CDM methodologies. Also, monitoring of a series of individual measures poses a significant challenge. Furthermore, the number of CERs gained per building is often too small to justify the transaction costs. In particular, monitoring of a large number of buildings requires substantial organisational efforts, resulting in high monitoring costs and risks.

Standardised approaches can provide solutions to these problems. A methodology that evaluates the emission performance of a whole building allows a **combination of measures** and gives **wider flexibility in technology choice**. **Monitoring is streamlined** as it is performed only at the building level; monitoring of each measure is necessary. By applying a performance standard, any change in the emission level is reflected in the emission performance. Although the CDM has conventionally focused on implementation of concrete mitigation technologies (hard measures), **the performance standard also needs to work with management measures** that reduce emissions through operational improvement or behavioural changes (soft measures).

Our recommendations on the key technicalities of the standardised approaches to whole-building efficiency projects are summarised in Table 5. **A careful balance in the choice of aggregation level plays a key role,** as there are numerous factors influencing building emission performance. It is likely that a rather high degree of disaggregation is necessary for development of a performance standard. Further, the data requirements are rather heavy, and the data availability is limited in most host countries. Therefore, it is recommended that the initial efforts focus on **homogeneous, energy-intensive building unit categories** (e.g., residential) in **regions with high potential for replicability** (e.g., East Asia, South Asia, and Middle East & North Africa).

The proposed standardised approach would likely improve the environmental effectiveness, cost effectiveness, and sectoral and project-size distributions. The geographical distribution can be improved provided there is significant international support for institutional capacity building and concerted data collection. **Institutional feasibility will likely be the key concern.** Monitoring, reporting and verification of building data require extensive organisational efforts. The lack of an obvious candidate for a performance standard coordinator and the fragmented nature of the building sector add to institutional complexity. **Limited data availability and institutional capacity in most host countries need to be overcome through international support.**

Table 5: Summary of standardised approach to whole-building efficiency improvement

	Description
System boundary	Project and baseline building units, plus energy systems supplying energy to the building units.
KPI	tCO_2e per m^2 of a building unit.
Aggregation level	(1) Process: Not differentiated. (2) Product: Similar building type and size. (3) Time: New vs. existing building units. If appropriate, differentiate existing building units by building age. (4) Space: Similar climate conditions (or adjustment by heating degree days and cooling degree days), and similar level of economic development (only in areas with an advanced level of economic development).
Data requirements	Disaggregation of building units: • Building unit size, type, and age. • Climate conditions. • Economic development. Calculation of standardised baselines: • Energy consumption. • Refrigerant leakage. • Transmission & distribution loss of energy. • Emission factor for energy consumption and refrigerants leakage. • Techno-economic analysis of building efficiency measures.
Stringency level	Baseline: The mean emission level of peer building units. Additionality: The baseline level adjusted by the improvement in emission performance by non-additional measures (case-specific).
Updating frequency	Annual update.

7.1 Relevance of the sector for standardised approaches

Every year around four billion square meters are constructed worldwide (Richerzhagen et al. 2008). Approximately 30-40% of global primary energy is used in residential and public buildings. The pattern of energy use in a building is strongly related to the building type and the climate zone in which it is located. Importantly, 80-90% of the life-cycle building energy consumption occurs during the operational phase. This clearly shows the need to producing more energy-efficient buildings and renovate existing building stocks (UNEP 2007). Through mitigation measures in the residential and commercial sectors, approximately 3.2, 3.6 and 4.0 billion tCO_2e can be avoided globally from the BAU level in 2020 at zero cost, €14.5/tCO_2e and €73/tCO_2e respectively (Levine et al. 2007).[43] More than half of the mitigation potential is found in developing countries.

Despite the high theoretical potential and urgency of building efficiency improvement, the CDM has not been able to mobilise a significant volume of such projects. CDM projects in this category account for less than 1% of the overall volume of CERs to be generated by the end of 2012; 5 million CERs are expected from the building sector in the context of a total of 2,840 million CERs from all the CDM projects submitted to the UNFCCC (UNEP Risoe Center 2009).

One of the most significant barriers to efficient building design is that buildings are complex systems. Minimising energy use requires optimising the system as a whole by systematically addressing building form, orientation, envelope, glazing area and a host of interaction and control issues involving the building's mechanical and electrical systems (Levine et al. 2007). Furthermore, a combination of different measures would lead to positive (or negative, if badly designed) synergy effects. Therefore, the energy savings and costs of each measure are not additive (Thorne 2003).

Given this technical complexity, one of the key bottlenecks for building efficiency projects under the CDM is the lack of appropriate baseline and monitoring methodologies (Hayashi and Michaelowa 2007; Müller-Pelzer and Michaelowa 2005). Most of the CDM methodologies for the building sector have focused on the technology-specific approach (system-specific approach). There are only a few methodologies[44] that can accommodate holistic, integrated approaches to building efficiency improvement (whole-building approach) mainly because the interaction of measures makes it difficult to establish a clear causality between the measures and

[43] Converted from the original figures of \$20/tCO_2e and \$100/tCO_2e.

[44] These are AMS-II.E "Energy efficiency and fuel switching measures for buildings" and AMS-III.AE "Energy efficiency and renewable energy measures in new residential buildings". The former does not give detailed procedures for emission reduction calculation, so it has not been used widely. The latter is a newly approved methodology that was made available.

the resulting emission reductions. Furthermore, soft (or management) measures[45] have explicitly been excluded from the CDM since they normally do not require capital investment in a mitigation technology and so do not necessarily lead to stable, long-term emission reductions. However, soft measures are as important as deploying technological improvements in reducing building energy consumption (UNEP 2008). In addition, the amount of CERs gained per building is often too small to justify the transaction costs. In particular, monitoring a large number of buildings requires substantial organisational efforts, resulting in high monitoring costs and risks. The lack of whole-building methodologies makes it difficult to increase the financial viability of this project type as the system-specific approach yields a far smaller amount of CERs per building.

Standardised approaches can provide solutions to the above two problems, methodological and organisational barriers. A methodology that evaluates emission performance of a building (e.g., in tCO_2/m^2) would provide three main benefits:

1. **It allows a combination of measures.** The combination of measures would increase the amount of CERs per building and so improves the financial viability of a building efficiency project. Importantly, standardised baselines need to work with soft measures, as any mitigation effort will be reflected in the building emission performance.
2. **It gives wider flexibility in technology choice**. Flexible technology choice is important because building efficiency improvement typically requires a range of different, small measures suitable for specific local circumstances. Also, new measures could be installed over time (UNEP 2008).
3. **It streamlines monitoring requirements**. By using the performance-based methodology, monitoring of emission reductions will be performed at a building level, but not at an equipment level. The monitoring of whole-building emission performance inherently accommodates a complex interaction of measures, and thus avoids the challenging monitoring of the emission impact of each such interaction. In addition, the holistic monitoring approach is especially helpful for residential buildings since they usually do not have centralised control systems for appliances (e.g., lighting in a corridor) or cooling/heating devices. Hence, it is not practical to require monitoring of each measure (UNEP 2008).

The following sections explain how performance standards can be established for whole-building efficiency improvement projects. In our definition, this project category includes both energy efficiency and fuel switching measures. The following key aspects of performance standards are discussed:

- System boundary: A physical boundary for accounting for GHG emissions.
- KPI: An indicator used for comparison of emission performance of the project against peers.

[45] Soft measures include using good standard operation procedures, proper commissioning, good maintenance, optimizing operational conditions, recordkeeping, providing proper consumption information feedback, etc. (Hinostroza et al., 2007).

- Aggregation level: Criteria for identification of peers for the emission performance comparison. Four key dimensions are process, product, time, and space.
- Data requirements: Data required for the development of a performance standard, and availability of such data.
- Stringency level: The level of a performance standard for baseline emissions and/or additionality demonstration.
- Updating frequency: Required frequency for updating of a performance standard over time.

7.2 System boundary

In consideration of a system boundary, it is necessary to distinguish two possible units of analysis for the building efficiency performance: the entire building or a building unit. A building unit is a distinct space within a building allotted to a specific user. For instance, a single family home is one residential building unit while a building with ten apartments has ten residential building units. As explained in Ch. 7.2 below, building types (e.g., residential, commercial, institutional) have important impacts on building energy consumption levels. Therefore, **it is essential to distinguish buildings by type and establish a baseline for each building type.** This helps increase accuracy in estimating emission performance of buildings in a certain building category. The use of building units is especially important for regions in which mixed-use buildings are dominant. By using building units with the same function in a mixed-use building, one can homogenise the sample to be used for establishing a standardised approach. Furthermore, as compared to buildings, the use of building units increases the size of building samples for the emission reduction calculation. The larger sample size would result in a smaller penalty in adjusting the emission reductions by sampling error[46].

There is also a drawback in using the building unit approach. Energy consumption data are monitored either for individual building units or only for a whole building (it depends on the specific setup of monitoring devices for certain energy sources). In case of the latter, the energy consumption monitored at the whole building level needs to be apportioned to individual building units, e.g., in proportion to the gross floor area of the building unit.[47] Thus the apportioned energy consumption does not necessarily reflect the actual energy consumption of a building unit. This can decrease accuracy in estimating the energy performance of the building unit.

[46] If sampling is used in emission reduction calculation, CDM methodologies require a conservative adjustment of emission reductions by sampling error. For the baseline emissions, it requires the use of the lower bound of a confidence interval established for the mean estimate. On the other hand, the project emissions need to be adjusted by using the higher bound of a confidence interval for the mean estimate. As a larger sample size helps narrow the confidence interval, it will eventually lead to a smaller penalty in the emission reductions.

[47] The energy consumed in the common spaces (e.g., corridors) can also be apportioned to individual building units in proportion to the floor area of the building unit.

However, the advantage of the improved homogeneity of building samples and the larger sample size would likely outweigh this disadvantage. Therefore, **the use of building units is recommended**[48].

Emission sources for the operation of a building unit include emissions from energy consumption and refrigerant leakage. The former is related to the consumption of electricity, fuels (e.g., natural gas, coal/coke, fuel oil, propane & liquid propane, biomass), and central building/district energy (e.g., steam, hot water, chilled water). The latter is associated with the use of air conditioners and refrigerators. Furthermore, renewable-energy generating systems (e.g., a photovoltaic system) can be included as negative emission sources if the energy is supplied to other users[49]. All the emission sources that are significant, and under control of, and reasonably attributable to the project shall be included in the boundary. An emission source is commonly considered significant if it contributes more than 1% of the total baseline/project emissions (Michaelowa et al. 2007).

In sum, the system boundary for whole-building efficiency projects should include all the building units constructed by the project (project building units) and the building units monitored for the baseline calculation (baseline building units), plus the spatial extent of the energy supply systems supplying these building units (e.g., electricity grid, central building/district energy systems). Whether the emission sources listed above need to be included in the boundary depends on their significance in the project-specific conditions. Outside the boundary, significant leakage sources need to be accounted for. If biomass is used as a fuel, for instance, leakage could occur due to the diversion of biomass from other uses to the buildings constructed by the project activity[50].

7.3 Key performance indicator

Measuring energy performance per square meter is a common indicator for energy management in buildings and is suitable for project management purposes (UNEP 2008). Two such indicators are used in the analytical literature: (1) an energy use index (EUI), and (2) an energy intensity (EI). Both indicators use annual energy consumption as the numerator of a KPI. For the denominator, an EUI employs the floor area served by the fuel and end-use in question, while an EI employs the total floor area. For example, for a building unit, make the following assumptions:

- The floor area of a building unit is 150 m^2.
- The air-conditioned floor area is 100 m^2.
- Total annual electricity consumption for air-conditioning is 3,000 kWh.

[48] AMS-III.AE "Energy efficiency and renewable energy measures in new residential buildings" indeed uses building units as the unit of analysis.
[49] If the energy is used by the building unit itself (own consumption), it will simply be considered as zero-(or low-)carbon energy consumption within the boundary.
[50] For procedures to address such leakage, see ACM0006 "Consolidated methodology for electricity generation from biomass residues".

Then the air-conditioning EI would be 20 kWh/m^2 (3,000 divided by 150), while the EUI would be 30 kWh/m^2 (3,000 divided by 100).

The EUI approach measures energy performance of a specific end-use. As the area not served by the end-use (e.g., air conditioning) is excluded from the performance calculation, it is a more accurate indicator of how efficiently the input energy is used to yield a certain output. On the other hand, the necessary measurement of service area for each end-use type adds monitoring complexity. Furthermore, the use of different units in denominator (e.g., air-conditioned area, lighted area) makes it difficult to sum up individual indicators to derive the overall specific emissions of the building unit.

The EI approach is a more straightforward approach that applies the same floor area to any energy end-use in a building unit. It does not establish as clear an input-output relationship as the EUI approach. But the simplicity and objectivity of the approach is appealing, especially in developing countries where precise data are not readily available. The EI approach can be adapted for an emission performance comparison. By using **emissions in the numerator and gross floor area (GFA) in the denominator**, the KPI is expressed as follows:

$$\text{KPI}: \frac{[\text{tCO}_2\text{e}]}{[\text{m}^2]}$$

The project emissions can be calculated as follows[51]:

$$PE_y = \sum_i \sum_j \left(PE_{EC,i,j,y} + PE_{FC,i,j,y} + PE_{CWC,i,j,y} + PE_{HWC,i,j,y} + PE_{SC,i,j,y} + PE_{ref,i,j,y} \right)$$

Where:

PE_y	=	Project emissions of project building units in year *y* (t CO_2e/yr)
$PE_{EC,i,j,y}$	=	Project emissions from electricity consumption of project building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$PE_{FC,i,j,y}$	=	Project emissions from fossil fuel consumption of project building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$PE_{CWC,i,j,y}$	=	Project emissions from chilled water consumption for space cooling of project building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$PE_{HWC,i,j,y}$	=	Project emissions from hot water consumption of project building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$PE_{SC,i,j,y}$	=	Project emissions from steam consumption for space heating of project building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$PE_{ref,i,j,y}$	=	Project emissions from the use of a refrigerant(s) in project building unit *j* in building unit category *i* in year *y* (t CO_2e/yr)

Using the KPI, the baseline emissions can be calculated as follows:

[51] For the sake of simplification, the detailed procedures for the calculation of each emission source are omitted.

$$SE_{BL,i,j,y} = \frac{BE_{i,j,y}}{GFA_{BL,i,j,y}}$$

Where:

$SE_{BL,i,j,y}$	=	Specific emissions of baseline building unit *j* in building unit category *i* in year *y*, defined as emissions per GFA in square metres per year (t CO_2e/(m^2·yr))
$BE_{i,j,y}$	=	Baseline emissions of baseline building unit *j* in building unit category *i* in year y (t CO_2e/yr)
$GFA_{BL,i,j,y}$	=	GFA of baseline building unit *j* in building unit category *i* in year *y* (m^2)

$$BE_{i,j,y} = BE_{EC,i,j,y} + BE_{FC,i,j,y} + BE_{CWC,i,j,y} + BE_{HWC,i,j,y} + BE_{SC,i,j,y} + BE_{ref,i,j,y}$$

Where:

$BE_{i,j,y}$	=	Baseline emissions of baseline building unit *j* in building unit category *i* in year *y* (t CO_2e/yr)
$BE_{EC,i,j,y}$	=	Baseline emissions from electricity consumption of baseline building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$BE_{FC,i,j,y}$	=	Baseline emissions from fossil fuel consumption of baseline building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$BE_{CWC,i,j,y}$	=	Baseline emissions from chilled water consumption for space cooling of baseline building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$BE_{HWC,i,j,y}$	=	Baseline emissions from hot water consumption of baseline building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$BE_{SC,i,j,y}$	=	Baseline emissions from steam consumption for space heating of baseline building unit *j* in building unit category *i* in year *y* (t CO_2/yr)
$BE_{ref,i,j,y}$	=	Baseline emissions from the use of a refrigerant(s) in baseline building unit *j* in building unit category *i* in year *y* (t CO_2e/yr)

Based on the specific emissions of each building unit calculated, plot a cumulative frequency curve of the specific emissions of the building units. An exemplary cumulative frequency curve is shown in Figure 12.

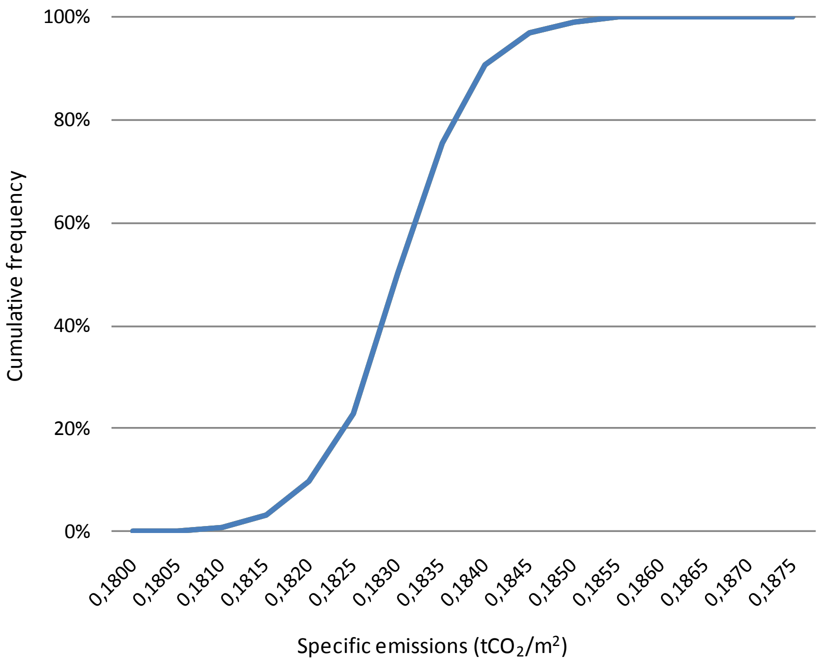

Figure 12: Cumulative frequency curve of specific emissions of building units

Note: The specific emissions figures are only indicative.

Decide on the level of stringency for the performance standard (this issue will be discussed in detail in Ch. 7.6). The chosen level of standard specific emissions ($SSE_{i,y}$) will then be multiplied by the total GFA of the project building units.

$$BE_y = \sum_i SSE_{i,y} \times GFA_{PJ,i,y}$$

Where:

BE_y = Baseline emissions of baseline building units in year *y* (t CO_2e/yr)

$SSE_{i,y}$ = Standard specific emissions of building units in building unit category *i* in year *y*, defined as emissions per GFA in square metres per year (t $CO_2e/(m^2 \cdot yr)$)

$GFA_{PJ,i,y}$ = Total GFA of project building units in building unit category *i* in year *y* (m^2)

7.4 Aggregation level

Building energy consumption patterns are largely influenced by building type and climate conditions. Furthermore, the level of economic development in the area and the building age are also influential factors (Natural Resources Canada 2003; UNEP 2007; WBCSD 2008b). There are also other factors contributing to the variations in building energy consumption patterns, such as building size, geography, demographics, the number and lifestyle of occupants, etc.

Where distinctive differences in building emission performance are observed (e.g., residential vs. commercial buildings, warm vs. cold climate), buildings need to be categorised into separate groups and a standardised approach needs to be established for each category. Therefore, adding aggregation dimensions increases the number of standardised approaches, while it generally improves the accuracy of the baselines. Given the wide range of determinants for building efficiency levels, a carefully balanced choice of aggregation level plays a key role. The following section discusses how the appropriate aggregation level should be determined for the four dimensions of aggregation.

7.4.1 Process aggregation

The process dimension asks whether standardised approaches are differentiated by technology or process. For instance, one could think of such differentiation in terms of access to certain types of energy and/or building material and technology locally available.

However, **differentiation by technology or energy type would hinder improvement of emission performance beyond the defined technology or energy category.** This would result in a weaker signal for a low-carbon development path.

Furthermore, the wide range of building materials and technologies available today makes it difficult to disaggregate standardised approaches on this basis. A more pragmatic solution would be to use a reasonably defined spatial boundary. The energy access issue can also be addressed in this manner.

7.4.2 Product aggregation

Building type

Above, we broadly defined the product as the GFA of a building unit. We also noted that building energy consumption patterns would be strongly influenced by building type. The following figure shows the influence of building type on building electricity use, taking US buildings as an example. The large variation in the electricity consumption pattern clearly shows the necessity of disaggregating standardised approaches by building type. In general, residential building units are more homogeneous in energy consumption pattern than are commercial and institutional building units. Therefore, it is easier to develop a performance standard for residential building units. Within the commercial or institutional category, some sub-categories (e.g., offices, hotels, supermarkets) are more energy consuming in absolute terms than others (e.g. hospitals, schools). Therefore, **it is recommended to target homogeneous, energy-intensive building unit categories** to ensure that the efforts towards performance standard development pay off eventually.

Table 6: Average energy intensity by building type in the US in 2003

Building type	kWh/m^2 year	Ratio
Dwellings	147	1
Retail	233	1.6
Schools	262	1.8
Offices	293	2
Hotels	316	2.1
Supermarkets	631	4.3
Hospitals	786	5.3
Restaurants	814	5.5

Source: EIA (2003) (cited in Pérez-Lombard et al. 2008)

The definition of building types poses an important trade-off. The more disaggregated the building types are, the more accurate a standardised approach becomes, thanks to the increased homogeneity of building efficiency patterns. However, the increased number of building types results in higher transaction costs as standardised approaches need to be established for each building type. Thus, the definition **needs to strike a balance between accuracy in emission reduction calculation and transaction costs**. As there is no consensus on a universal classification of building types, especially for non-residential buildings (Pérez-Lombard et al. 2008), it is first necessary to establish a standardised typology of buildings. A CDM methodology for whole-building efficiency projects recently submitted to the UNFCCC provides a list of building types based on the experience of several building codes and building efficiency programmes worldwide[52].

Building size

Also important is the size of a building. As building size increases, the specific energy consumption of the building often decreases thanks to economies of scale. For example, a multi-story residential building can operate a centralised air-conditioning system serving all the building units within the building. The centralised system is likely to result in a lower specific energy consumption level than, e.g., a single-family residential building. On the other hand, increased floor space does not lead to a monotonous improvement in energy intensity ratio. As the Canadian example in Figure 13 shows, building energy intensity can start increasing beyond a certain building size (Natural Resources Canada 2003).

[52] NM0328: "Energy efficiency and fuel switching measures in new buildings". Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/publicview.html?meth_ref=NM0328.

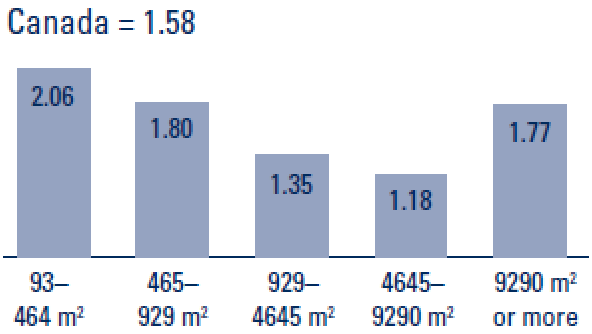

Figure 13: Energy intensity of Canadian commercial and institutional buildings by building size (GJ/m^2)

Source: Natural Resources Canada (2003)

Nonetheless, Figure 13 indicates that definition of a comparable building size is necessary to establishing a standardised approach[53]. Under the CDM, ACM0013, applicable to efficient fossil-fuel power generation projects, first defined a "similar" size as ± 50% of the size of the project power plant. This condition has been adopted in AMS-III.AE for energy efficiency and renewable energy measures in new residential buildings.

The building size can be used as a proxy for the number of occupants, which also has an important impact on the building emission performance. These two parameters are correlated – though not perfectly, as a building can be occupied by fewer people than it is designed for[54]. When deciding on the appropriate level of aggregation, it is important to keep the degree of disaggregation as low as reasonably possible because a highly disaggregated performance standard will increase transaction costs. Differentiation by the number of occupants is possible. But it would greatly increase the complexity of standardised approaches. Number of occupants is an unstable parameter as it can change frequently over time. It would thus lead to frequent reclassification of categories used for development of standardised approaches. Given the overlap between the building size and the number of occupants, and the greater stability of the former, **it is advisable to use only the building size as the basis for differentiation.**

Given the above points, it is recommended that the product be defined as **the GFA of a building unit** that serves **a specific type of building usage** and has **a comparable size** to the project building units.

[53] An argument against differentiation by building size is that economies of scale are also a means to improve building efficiency. However, a standardised baseline should not discriminate against smaller buildings. Construction of large buildings is not always possible (if there are no resources for it) or necessary (if there is no demand for it). Therefore, we consider it necessary to differentiate by building size.

[54] It is clear that unoccupied building units need to be excluded from the basis for the standardised baselines.

7.4.3 Temporal aggregation

Building age

The temporal dimension assesses the age or vintage of peers for comparison. Building age is an important factor influencing building energy performance (Natural Resources Canada 2003; WBCSD 2008b). The Canadian example in Figure 14 shows that newer buildings are more energy efficient, but does not necessarily indicate that the oldest are the least efficient (e.g., see buildings constructed before 1920). Construction standards, techniques, materials and types available around the year of construction exert a direct impact on specific energy use (Natural Resources Canada 2003).

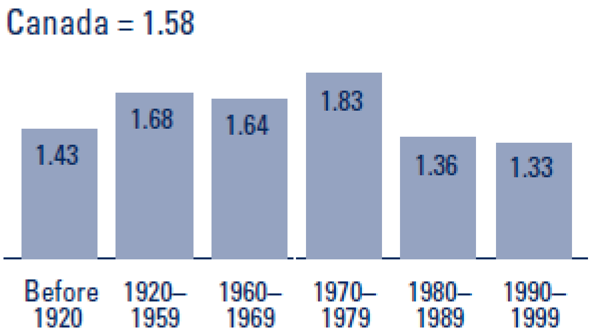

Figure 14: Energy intensity of Canadian commercial and institutional buildings by year of construction (GJ/m^2)

Source: Natural Resources Canada (2003)

As mentioned above, **an apparent need for temporal disaggregation is a distinction between new and existing buildings.** Within the existing building category, however, the causality between building age and energy performance can be obscure in some cases (e.g., the Canadian case above). Therefore, it is necessary to judge on a case-by-case basis whether such differentiation makes sense. If there is a clear relationship between the building age and efficiency, and the efficiency level of old buildings are far lower than the newer ones, it makes sense to differentiate the existing buildings by building age (i.e., a less stringent baseline for older buildings, a more stringent one for newer buildings). In such a case, establishing different levels of standardised approaches would help incentivise old buildings to improve their efficiency, while keeping the baseline for newer buildings at a reasonably stringent level.

7.4.4 Spatial aggregation

Climate conditions

The spatial dimension determines the geographical boundary in which the peers are located. As to spatial aggregation, the key determinant is climate conditions

(ASHRAE 2002). Figure 15 shows the influence of climate conditions on building energy use patterns, taking the US as an example. Obviously, heating demand is higher in colder climates, while hotter regions require more energy for cooling. Climate also strongly influences building design. For example, colder climates tend to have better air tightness and insulation. Humidity and rainfall are also important factors, as is temperature (WBCSD 2008b).

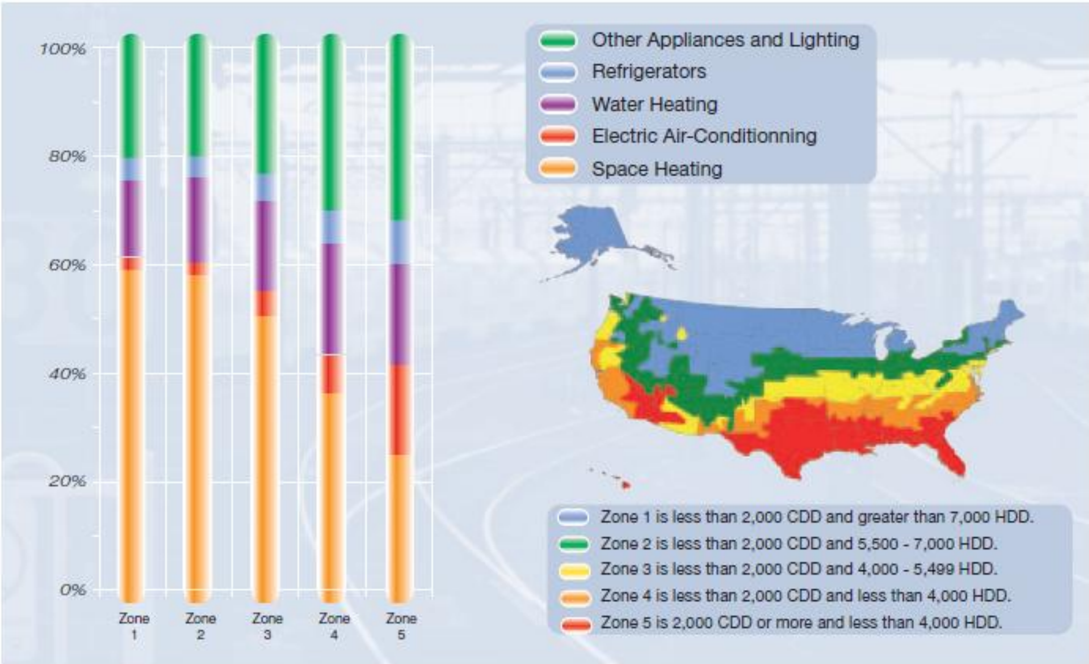

Figure 15: Energy consumption of US residential buildings by climate zone

Source: US EIA (2001) (cited in UNEP 2007)

The Köppen climate classification defines six major groups[55], which are used by organisations such as the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) (WBCSD 2008b). Spatial disaggregation by climate conditions is essential (e.g., based on the Köppen climate classification). Accordingly, **standardised approaches need to be established for each climate classification.**

However, such spatial disaggregation can be a complex exercise if the area concerned accommodates multiple climate zones. **Alternatively, a climate-neutral standardised approach can be established, and it can be adjusted by the impact of the local climate conditions.** Such adjustment is commonly performed by a regression analysis using heating degree days (HDD) and cooling degree days (CDD) as independent variables representing the key climate conditions. For instance, the ASHRAE, the US EPA's Energy Star® building energy performance ratings and AMS-III.AE under the CDM employ this approach (ASHRAE 2002; US

[55] Group A: Tropical/mega-thermal climates, Group B: Dry (arid and semiarid) climates, Group C: Temperate/meso-thermal climates, Group D: Continental/micro-thermal climate, Group E: Polar climates, and Group H: Alpine climates.

EPA 2009d)[56]. HDD and CDD are common measures that reflect the heating and cooling requirements of a building, relative to the average temperature. In most rating models, HDD and CDD are determined to have statistically significant impacts on energy use. The US EPA also performed analysis to determine whether humidity effects require additional adjustment beyond HDD and CDD, but could not determine that a separate relationship for humidity was statistically significant. Most of the numerous climate conditions that may influence a building's operation are correlated with each other. Thus, it is not feasible to identify separate adjustments for each characteristic. The US EPA's analysis reveals that HDD and CDD are good indicators for climate conditions (US EPA 2009d). Though the analysis was conducted in the US context, the insight is very valuable given that the US accommodates various climate conditions (see Figure 15).

Economic development

Level of economic development is often said to influence building energy consumption (e.g., WBCSD 2008b). As the term economic development is very broadly defined, we use income level as one of the key indicators for level of economic development. It makes intuitive sense to say, "The higher the income, the more energy people consume." However, an extensive survey on urban household energy consumption patterns in 45 cities in 13 developing countries shows that, although income is strongly related to the energy type chosen, it is not as related to the total quantity of energy used, except in the higher income class (Barnes et al. 2004). Figure 16 shows that the total energy consumption of households with low or moderate incomes is quite comparable. The explanation lies in the fact that households shift from lower-efficiency traditional fuels to higher-energy-value modern fuels as they move up the income ladder (Barnes et al. 2004).

[56] The detailed procedures are available in ASHRAE (2002), US EPA (2009d), and AMS-III.AE (http://cdm.unfccc.int/UserManagement/FileStorage/CDM_AMS02DI2P0YCXF0W6W3D6HV1KX6NWQ8O0).

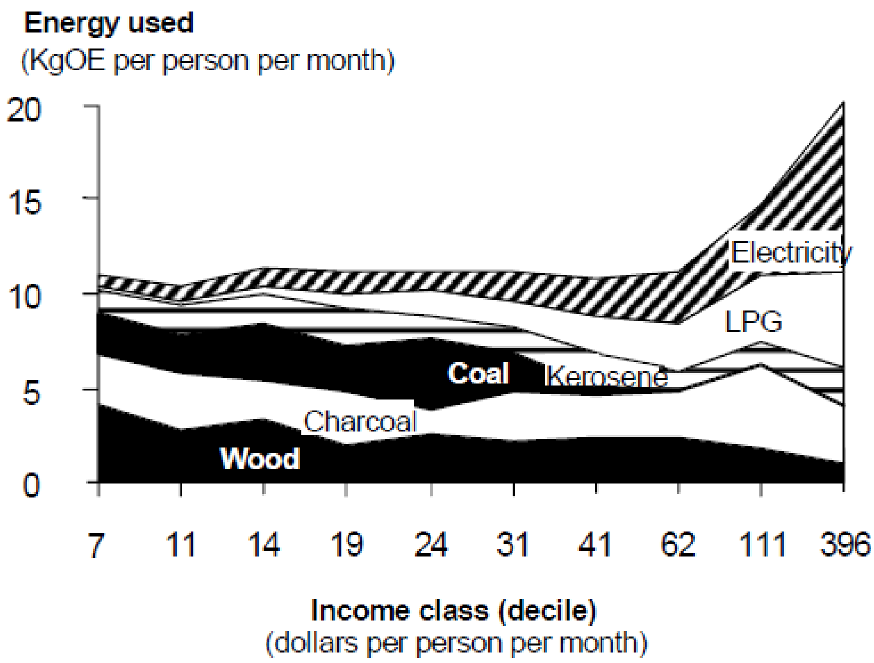

Figure 16: Income class and quantity of fuels consumed in 45 cities in 13 developing countries in Africa, Asia, Latin America and the Caribbean and the Middle East

Note: The cities covered in the survey are as follows:

- Africa: Botswana, Burkina Faso, Cape Verde, Mauritania, Zambia, and Zimbabwe.
- Asia: Indonesia, India, Thailand, and the Philippines.
- Latin America and the Caribbean: Bolivia and Haiti.
- Middle East: Yemen.

Source: Barnes et al. (2004)

The above analysis is limited to urban household energy consumption patterns, and thus excludes other building types (e.g., commercial, institutional) or residential buildings in rural areas. However, we expect similar patterns elsewhere because the total energy consumption stays at a comparable level until the level of economic development of the area reaches a certain level, but the choice of energy type is always strongly influenced by the economic conditions.

This indicates that differentiation by level of economic development is necessary only if the area has reached a certain threshold level (e.g., $60 per person per month, using a household income level as a proxy for economic development). Differentiation for lower levels of economic development does not seem justifiable. Although level of economic development is strongly related to the choice of energy type, it is not recommended that standardised approaches be disaggregated by energy type. Again, **standardised approaches should be neutral of energy type in order to provide a clear signal for a low-carbon development path**.

Considering the above discussion, the spatial boundary for the establishment of a standardised approach should have comparable climate conditions and, if appropriate, a comparable level of economic development. The **appropriate boundary will most likely be sub-national, but can be national or supra-national depending on the specific situation**.

7.5 Data requirements

Monitoring parameters

In order to operationalise the standardised approach, it is first necessary to collect data required for the disaggregation of building units. The required data are: building type, size and age, climate conditions, and level of economic development.

Provided the above data for building disaggregation are available, the next step is to collect the data required for the standardised approach calculation, as summarised in Figure 17 and Table 10: CDM biomass methodologies related to energy efficiency and/or CH_4 avoidance in biomass pyrolysis. The figure and the table assume an exemplary building that consists of two building units. The building unit has electricity supplied by the grid, cooling by a centralised HVAC system (driven by electricity), and hot water by natural gas. Other types of energy are not utilised. Therefore, electricity consumption, fuel consumption, and refrigerant leakage are the main emission sources of the building unit[57].

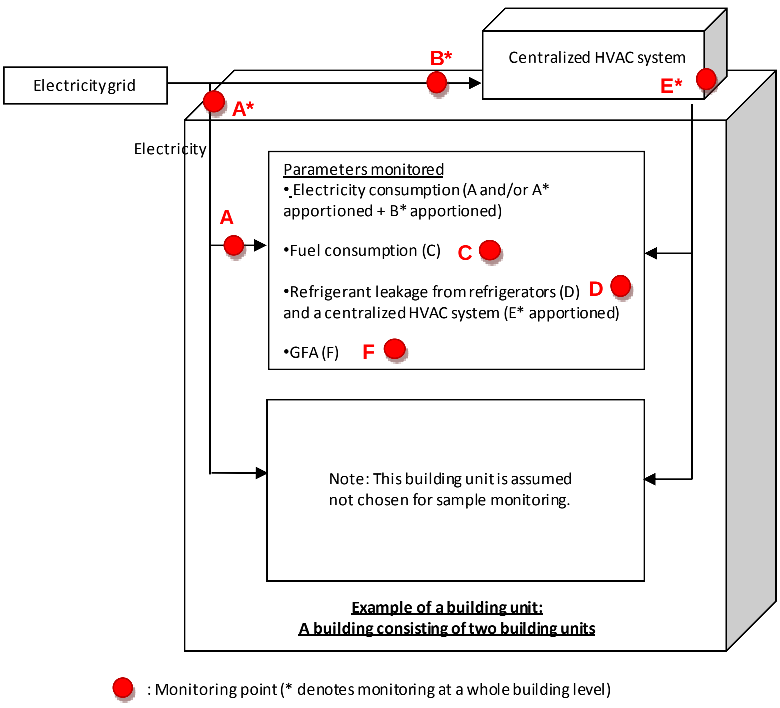

Figure 17: System boundary and monitoring points for whole-building efficiency projects

[57] If there are other types of energy consumed, they should be added to the emission sources.

Table 7: Key monitoring requirements for whole-building efficiency projects

Monitoring point	Data to monitor	Type of monitoring
A or A*	Electricity consumption	Direct and continuous metering of electricity consumption. If available, utility billing records can be used.
	Emission factor of the grid electricity	As per CDM Tool to calculate emission factor for an electricity system.[58]
	Transmission & distribution loss	Data from utility or an official government body.
B	Electricity consumed in the centralised HVAC system	Direct and continuous metering of electricity consumption. If available, utility billing records can be used.
C	Fuel consumption	Direct and continuous metering of fuel consumption. If available, utility billing records or fuel purchase invoices can be used.
	Net calorific value of the fuel	Values provided by the fuel supplier in invoices, own measurement, or regional or national default value.
	CO_2 emission factor of the fuel	Values provided by the fuel supplier in invoices, own measurement, or regional or national default value.
D	Refrigerant leakage from refrigerators	IPCC default value.
E*	Refrigerant leakage from the centralised HVAC system	Inventory data of refrigerant cylinders, or IPCC default value.
F	GFA of a building unit	Building plan, or onsite measurement.

In addition, data for techno-economic analysis of building efficiency measures will be necessary in order to determine the appropriate level of stringency of a performance standard for additionality demonstration (further discussed in Ch. 7.6). Such data include the maturity stage, cost-effectiveness, and appropriateness of the measures.

[58] Available at: http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf.

Data availability

Data on building type, size and age are not readily available in most developing countries. The GFA of building units can be obtained through building plans or onsite measurement. The former are available from, e.g., the building owner, real estate agents, government agencies regulating building constructions. Furthermore, data on level of economic development may also be difficult to obtain as frequent census surveys are not very common in developing countries. Therefore, extensive building occupant surveys are first required.

On the other hand, climate data are well-published for many developing countries. For instance, the world map of the Köppen climate classification can be obtained from publicly available sources (e.g., Kottek et al. 2006). More detailed data can be collected through weather stations, which are often located at airports and operated by the government. Also, a wealth of climate data has been arranged by the World Meteorological Organisation (WMO 2010).

In many cases, electricity consumption data are readily available through utility billing records. These can be collected through each building occupant, or centrally through the utility database. Fuel consumption data can also be derived from utility billing records if the fuel is supplied by a utility (e.g., natural gas). If fuel is purchased individually (e.g., LPG cylinder), fuel purchase invoices need to be collected from the building occupant.

The emissions from the use of refrigerants occur as leaks or by diffusion during the use phase of the equipment containing the refrigerants. Such emissions can be detected through equipment servicing. In practice, these emissions are difficult to monitor for small equipment used in building units (e.g., air conditioners, refrigerators), thus the use of IPCC default values for refrigerant leakage is recommended (Ashford et al. 2006). For larger equipment (e.g., central building/district cooling systems), inventory data of refrigerant cylinders consumed can be used.

Some techno-economic data of building efficiency technologies are available at an aggregate level (e.g., Levine et al. 2007). However, data availability is not universal. Given the high degree of disaggregation required for the standardised approach, the data need to be much more elaborated, reflecting the local conditions.

7.6 Stringency level

Standardised approaches are considered appropriate for both baselines and additionality. Whole-building efficiency projects typically involve a range of energy efficiency and fuel switching measures, implementation of which will be spread over the duration of the crediting period. For this reason, it would be difficult to undertake a solid barrier or investment analysis for the whole range of measures at the start of the project activity. Moreover, the standardised approach provides a good basis for assessing whether the efficiency of building units constructed during the project activity exceeds the common practice in the relevant geographical boundary. The use of emission-rate-based standardised additionality testing in AM0070 was justified with the same rationale.

The US offset programmes use standardised approaches to additionality testing based on either an emission rate, specifications on technology or practice, or a market penetration rate. The market penetration approach requires a clear definition of a mitigation measure and good overview of the market share of each measure. As there is likely a wide range of measures involved in a whole-building efficiency project, this approach faces difficulties in implementation. Specifications on technology or practice are possible. For instance, a building project that exceeds the efficiency level stipulated in the applicable energy standard by x% can be deemed additional. This approach has been used for whole-building efficiency projects in the RGGI offset programmes in the US. However, it is feasible only if there exists an energy standard applicable under the local conditions (e.g., Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE) for India). If such a standard does not exist, application of an energy standard used in industrialised countries (e.g., ASHRAE) could be an option as a conservative alternative. However, the appropriateness of such extrapolation may require case-by-case judgement. Among the three options, the emission-rate approach seems to be most widely applicable in developing countries. The determined level of emission performance would serve as the basis for assessing whether the building efficiency level exceeds the reference level in the relevant geographical area.

Stringency level for baselines

In order to derive an appropriate stringency level for a standardised approach, it is necessary to distinguish new and existing buildings. In principle, the baseline needs to reflect the level of emissions that would occur in the absence of the project activity. As a standardised approach is designed to serve multiple projects, it should "on average" represent the BAU emission level of these projects.

If it were possible to clearly identify the most economically attractive course of action (i.e., baseline approach 48.b), the set baseline would be a reasonable basis for the multi-project baseline. Given the complexity of whole-building efficiency projects, however, such an approach is likely to face challenges in practice. An alternative approach would be to look at what the common level of emission performance is for newly constructed buildings. This is similar to baseline approach 48.c which sets the baseline level as the average of the top 20% of performer buildings built in the last five years. However, the universal application of the top 20% average level is debateable because such a level is far below the common practice level (i.e., the mean) and so does not necessarily provide sufficient CER revenues to incentivise investment in low-carbon measures.

The top 20% average level works as a reasonable safety valve if building units are not appropriately disaggregated by the key criteria discussed inch. 7.4. Without the disaggregation, all building units will be captured in a single distribution curve as shown in Figure 18. Assume two CDM projects targeting efficiency improvement of (1) new buildings in a mild climate, and (2) old buildings in a cold climate. The former emits less CO_2 per m^2 as the buildings are built efficient and there is low demand for cooling or heating (the dashed circle on the left). The latter has higher emission intensity due to the use of inefficient building materials and technologies and the high heating demand (the dashed circle on the right). A standardised approach set at the top 20% average level would be suitable for the former category. But it is very likely too stringent for the latter. The catch-all approach covering any type of building efficiency project sets a stringent baseline as we do not know which part of the distribution curve a CDM project will target. Given the uncertainty, the baseline needs to be conservative in order to protect the environmental integrity of the CDM.

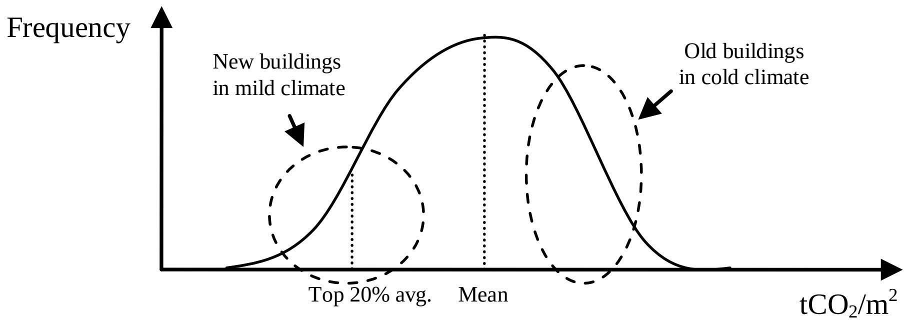

Figure 18: Distribution of emission performance of all buildings

If the building units are classified into different groups according to the key aggregation criteria, the distribution curve can be drawn for each category. Such a distribution curve has a narrower range as the buildings in a certain category are more homogeneous in terms of emission performance. As a standardised approach is designed for a specific target group, there is lower uncertainty in the baseline level. In this case, the mean emission performance of the respective category can set a reasonable baseline level. Thus, it is not necessary to use the overly stringent top 20% average level.

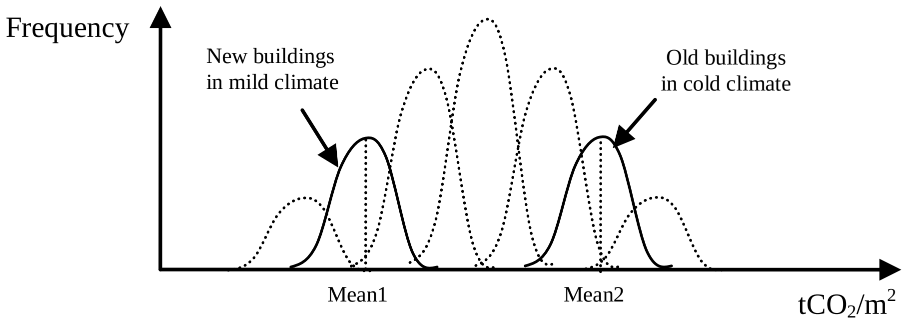

Figure 19: Distribution of emission performance of buildings by category

If standardised approaches are appropriately disaggregated, we argue that **the mean emission performance of each category would represent the most reasonable baseline level**. We proposed some guidance on the aggregation level in Ch. 7.4, but its application needs to be evaluated against the project-specific conditions.

Stringency level for additionality testing

In general, the same level of stringency can be used for the baseline emissions and the additionality testing of new installation projects. This argument is based on two assumptions: (1) the baseline is set at (or beyond) the level that represents the most economically attractive alternative, and (2) the baseline level does not differ significantly for new buildings in the respective category. Although the second assumption is likely to be valid, the first one needs further assessment. As whole-building efficiency projects are technically complex, we argued above that it is practically challenging to identify the most economically attractive course of action. Therefore, the mean of the actual emission performance of peer building units was proposed as the baseline level. This baseline level does not guarantee that there are no further efficiency measures that can be implemented in an economically attractive manner. As the first condition is not met, the baseline and additionality levels cannot automatically be set the same. Consequently, the differentiation of the baseline and additionality levels has to be made for both new and existing building projects.

The stringency level for additionality testing needs to be set at a level that can on average avoid crediting of non-additional projects. Therefore, the baseline level needs to be adjusted by the improvement in emission performance expected from the implementation of non-additional measures (Figure 19).

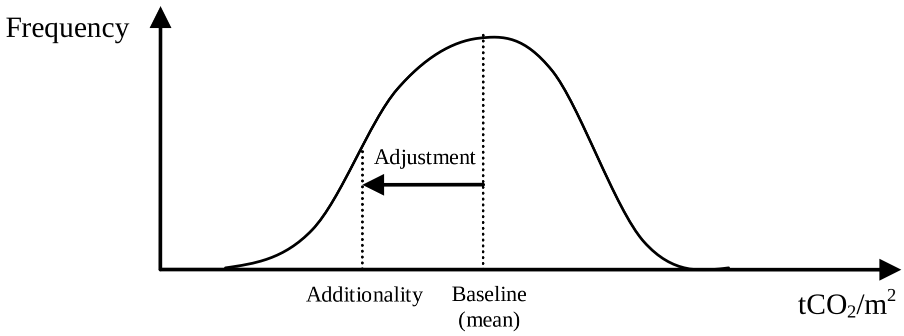

Figure 20: Baseline adjustment for additionality testing

The identification of non-additional measures requires detailed techno-economic analysis. Conventionally, the additionality of a CDM project is assessed by the investment and/or barrier analyses, complemented by the common practice analysis. A similar analysis can be conducted for the standardised approach, but at a more aggregate level. An example of such an analysis, found in Levine et al. (2007), summarised selected key building efficiency measures in five world regions based on three criteria: the cost-effectiveness, maturity, and appropriateness of the measure (Table 8)[59]. The first criterion is essentially the investment analysis, and the second and third criteria correspond to the barrier analysis. The analysis can help identify non-additional measures (e.g., a very mature, cost-effective, and appropriate measure)[60].

[59] Appropriateness includes climate, technological and cultural applicability.

[60] As to the cost-effectiveness criterion, it is of note that the costs of a measure do not necessarily reflect the real financial attractiveness of the measure. The transaction costs associated with the adoption of the measure needs to be considered as well. In particular, the “split incentives” that exist between tenants and landlords would increase the transaction costs.

Table 8: Applicability of building efficiency technologies in different regions

Energy efficiency or emission reduction technology	Developing countries						OECD						Economies in transition, Continental		
	Cold climate			Warm climate			Cold climate			Warm climate					
	Technology stage	Cost/ effectiveness	Appropri-ateness	Technology stage	Cost/ effectiveness	Appropri-ateness	Technology stage	Cost/ effectiveness	Appropri-ateness	Technology stage	Cost/ effectiveness	Appropri-ateness	Technology stage	Cost/ effectiveness	Appropri-ateness
Structural insulation panels	⬤	⬤	⬤	●	●	•	⬤	●	●	●	●	●	●	⬤	⬤
Multiple glazing layers	⬤	⬤	⬤	⬤	●	•[1] ●[2]	~	⬤	⬤	⬤	⬤	●	⬤	⬤	⬤
Passive solar heating	⬤	●	●	⬤	●	•	⬤	●	⬤	⬤	●	●	⬤	●	⬤
Heat pumps	●[3]	•	•	● ⬤[4]	•[5] ●[6]	•[7] ●[8]	⬤[9]	●	●	~[10] ⬤[11]	●[12] ⬤[13]	●[14] ⬤[15]	⬤[16]	●	●
Biomass derived liquid fuel stove	⬤	●	⬤	●	•	•	~	●	⬤	~	●	•	~	⬤	⬤
High-reflectivity bldg. materials	•	•	•	●	⬤	●	⬤	●	●	~	●	⬤	⬤	●	●
Thermal mass to minimize daytime interior temperature peaks	~	⬤	●	~	⬤	•[17] ⬤[18]	~	⬤	●	~	⬤	•[19] ⬤[20]	~	⬤	⬤
Direct evaporative cooler	•	•	•	~	⬤	•[21] ⬤[22]	•	•	•	~	⬤	•[23] ⬤[24]	•	•	•
Solar thermal water heater	~	⬤	⬤	⬤	⬤	⬤	~	⬤	⬤	~	⬤	⬤	~	⬤	⬤
Cogeneration	⬤	●	●	●	•	•	~	●	⬤	~	●	●	⬤	●	⬤
District heating & cooling system	⬤	●	●	•	•	•	~	●	⬤	⬤	●	●	⬤	●	⬤
PV	⬤	●	●	•	•	•	~	●	⬤	⬤	●	●	⬤	●	●
Air to air heat exchanger	⬤	●	⬤	⬤	●	⬤	⬤	⬤	⬤	⬤	⬤	⬤	⬤	●	⬤
High efficiency lightning (FL)	~	●	⬤	~	●	⬤	μ	•	⬤	μ	•	⬤	⬤	●	⬤
High efficiency lightning (LED)	~	•	⬤	~	•	⬤	•	•	⬤	•	•	⬤	•	●	⬤
HC-based domestic refridgerator	●	●	⬤	●	●	⬤	~	⬤	⬤	⬤	●	•[25] ⬤[26]	⬤	●	⬤
HC or CO_2 air conditioners	•	~	μ	•	~	μ	•	●	●	•	•	μ[27] ●[28]	•	~	●
Advance supermarket technologies	•	⬤	⬤	•	⬤	⬤	~	⬤	⬤	●	⬤	⬤	●	⬤	⬤
Variable speed drives for pumps and fans	~	●	●	~	●	●	~	●	●	~	●	●	~	●	●
Advanced control system based on BEMS	⬤	●	●	⬤	●	●	⬤	●	●	⬤	●	●	⬤	●	●

Visual representation	Stage of technology	Cost/Effectiveness	Appropriateness
•	Research phase (including laboratory and development) [R]	Expensive/Not effective [$$/-]	Not appropriate [-]
●	Demonstration phase [D]	Expensive/Effective [$$/+]	Appropriate [+]
⬤	Economically feasible under specific conditions [E]	Cheap/Effective [$/+]	Highly appropriate [++]
~	Mature Market (widespread commercially available without specific governmental support) [M]	'~' Not available	'~' Not available
μ	No Mature Market (not necessarily available/not necessarily mature market)		

Source: Levine et al. (2007)

Note: [1] For heat block type; [2] For Low-E; [3] Limited to ground heat source, etc.; [4] For air conditioning; [5] For hot water; [6] For cooling; [7] For hot water; [8] For cooling; [9] Limited to ground heat source, etc.; [10] For cooling; [11] For hot water; [12] For hot water; [13] For cooling; [14] For hot water; [15] For cooling; [16] Limited to ground heat source, etc.; [17] In high humidity region; [18] In arid region; [19] In high humidity region; [20] In arid region; [21] In high humidity region; [22] In arid region; [23] In high humidity region; [24] In arid region; [25] United States; [26] South European Union; [27] United States; [28] South European Union.

A detailed techno-economic analysis needs to consider building efficiency measures that improve the building emission performance beyond the common practice level (i.e., the baseline). **The expected improvement in emission performance from non-additional measures is to be subtracted from the baseline in order to derive the additionality level**.

7.7 Updating frequency

Building energy consumption levels change greatly over time. Weather conditions have particularly strong impacts on energy consumption levels, so actual weather conditions need to be taken into account. This requires annual monitoring of the energy consumption data. Such annual monitoring can also incorporate autonomous improvement of the building energy performance (e.g., by adoption of efficient appliances over time). As emissions from the use of refrigerants are much more predictable[61], it is not necessary to require frequent updating of this parameter.

Update of the emission factors of the energy supplied to the building units can require extensive data collection efforts. If the energy supply systems are centralised (electricity grids, district cooling/heating systems), it is easier to collect the necessary data. However, data collection from the decentralised energy supply systems (e.g., fuels, central building energy systems) will likely be very laborious. If significant changes in the emission factors are not expected over time[62], they should be kept constant for the lifetime of the energy systems.

The GFA data need to be updated at a certain time interval in order to reflect possible changes in building size (AMS-III.AE sets the time interval as every third year). The typical frequency of building renovation in the relevant area can be a basis for the updating frequency of this parameter.

The techno-economic analysis of building efficiency measures requires extensive efforts. Therefore, updating frequency of the analysis should be kept as low as possible. The CDM requires additionality assessment of a project at the renewal of a crediting period, i.e. every seven years. This should serve as a reasonable basis for the updating frequency.

Given that energy consumption data require annual updating, **it would be appropriate for standardised approaches for these types of projects to be updated every year.**

7.8 Implications of the standardised approach

Environmental effectiveness

The environmental effectiveness of the standardised approach depends primarily on whether a performance standard can be set at the right level of stringency. It is generally possible to set appropriate baseline and additionality levels based on the proposed procedures. The disaggregation of building units will help increase the accuracy of the standardised approaches. The holistic, integrated approach will

[61] Refrigerant leakage patterns are well studied and default leakage rates are available in the IPCC inventory guideline (Ashford et al. 2006).
[62] For example, emission factors of fuels are not likely to change significantly over time.

increase the amount of CERs per building and simplify the overall monitoring requirements, **contributing to the scaling up of mitigation efforts in this sector.**

Cost effectiveness

The key to the cost effectiveness of the standardised approach is the level of aggregation. As there are many major factors influencing the building emission performance, it is most likely that multiple performance standards need to be established. If the necessary disaggregation would lead to a high number of performance standards, however, it is possible to focus on more homogeneous, energy-intensive building unit categories in order to be cost-effective. Given the significant replicability potential of building efficiency improvement projects, concerted efforts for establishing performance standards **would most likely lead to a significant reduction of overall transaction costs.**

Distributional considerations

Building projects are currently under-represented and commonly have micro- to small-scale emission reductions. Therefore, **standardised approaches are likely to improve sectoral and project-size distribution.** The impact on geographical distribution depends largely on the institutional capacity of host countries. As shown in earlier sections, the standardised approaches for this project category are very data-intensive, and the current availability of the required data is rather limited in most developing countries. Without international support, the approach may only be feasible in advanced developing countries. Hence, international support to host countries is essential for improving geographical distribution.

Institutional feasibility

Institutional feasibility will likely be the key concern. The limited availability of data creates a need for significant efforts of data collection. However, monitoring, reporting and verification of building data require extensive organisational efforts – this is one of the key reasons why building projects have not been implemented widely under the CDM. As opposed to large industries where industry associations are normally existent, the building sector does not have an obvious candidate for coordination of standardised approach development. The fragmented nature of the sector also adds complexity. Clearly, **significant international support for institutional capacity building and concerted data collection is necessary**.

7.9 Recommendations for further work

The development of standardised approaches for the building sector can be complex because a relatively high degree of disaggregation is necessary. Therefore, it is advisable to target more homogeneous, energy-intensive building unit categories first. The most prominent candidate for a pilot study would be residential building units. In the non-residential building unit categories, offices are likely the most replicable sub-category.

Judging from the IPCC's projection of CO_2 emission growth through 2030 shown in Figure 21, **the potential of CDM building projects would be most significant in East Asia, South Asia, and Middle East & North Africa**. Therefore, the initial efforts towards standardised approaches should ideally be put in these regions.

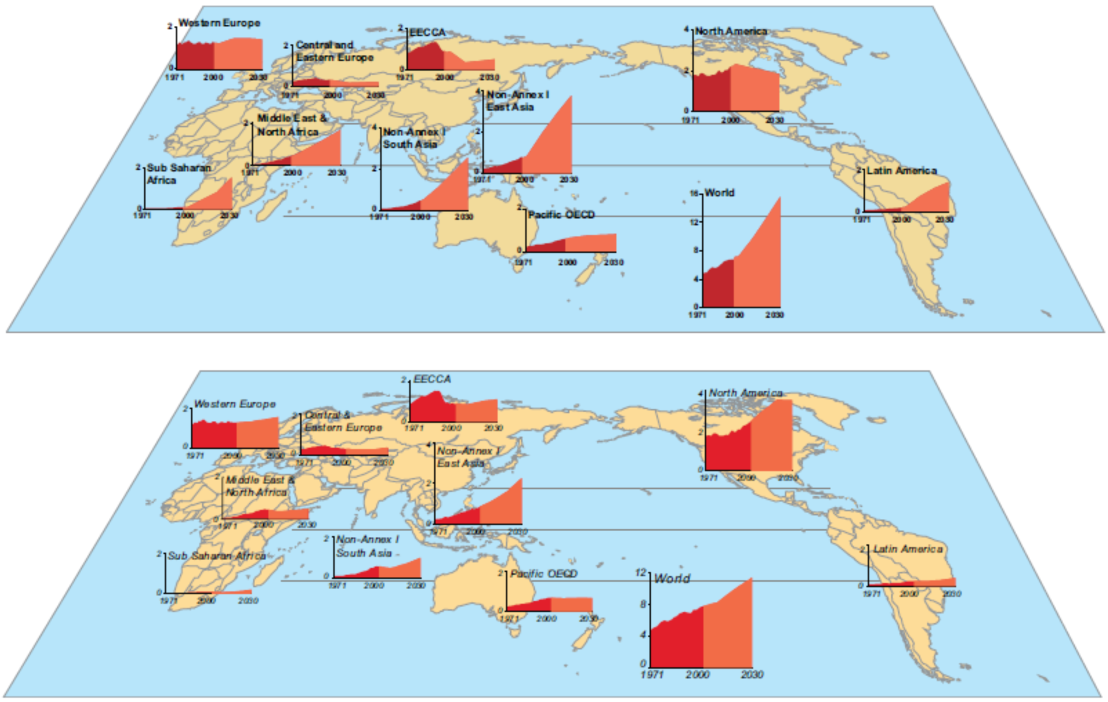

Figure 21: Projection of CO2 emissions from buildings through 2030, including emissions from the use of electricity: A1B (top) and B2 (bottom) IPCC SRES scenarios

Source: Levine et al. (2007)

Note: A1B scenario assumes a rapid growth of the world's economy, while B2 scenario describes a world with localised economies growing less rapidly.

The necessary steps for development of standardised approaches are summarised in Figure 22. Major **efforts should be put into data collection,** as availability of the necessary data is very limited in CDM host countries. The first step of data collection is to establish a database of building units with information on their size, type and age as well as climate conditions of their locations. If required, the level of economic development also needs to be surveyed. Except for climate conditions, for which data are readily available in the public domain, **the data collection will very likely require an extensive building occupant survey.** This database will serve as the basis for the identification of the baseline building units.

Secondly, all or a random sample of the building units needs to be monitored on energy consumption, refrigerant leakage, transmission & distribution loss in energy supply to these building units, and emission factors for energy consumption and refrigerant leakage. **The key parameters here are energy consumption and emission factors.** Other data should require less effort as default factors are available in IPCC reports or existing CDM methodologies. It is most efficient to partner with local utilities to obtain energy consumption data centrally from their databases. On the other hand, there could be consumption of energy that building occupants individually purchase or obtain (e.g., LPG cylinders, charcoal). In this case, one needs to conduct a building occupants survey or exclude these energy sources for conservative simplification[63]. The calculation of emission factors would require data from (captive) power plants or the central electricity authority if they organise such data. If district solutions to cooling, heating and/or hot water supply are applied to the baseline building units, the necessary data can be obtained from the utilities. Once the above data have been collected, a performance standard for baseline emissions can be established.

Lastly, the identification of non-additional measures would require detailed techno-economic analysis of building efficiency measures in the concerned area. The measures will need to be evaluated on, e.g., cost-effectiveness, maturity and appropriateness. **Thorough assessment of locally available building efficiency measures should be performed by independent experts with local expertise.**

[63] It is likely conservative because a building efficiency improvement project would reduce the consumption of these energy sources. Thus, the exclusion would result in a lower amount of CERs than the emission reductions that the project would actually achieve.

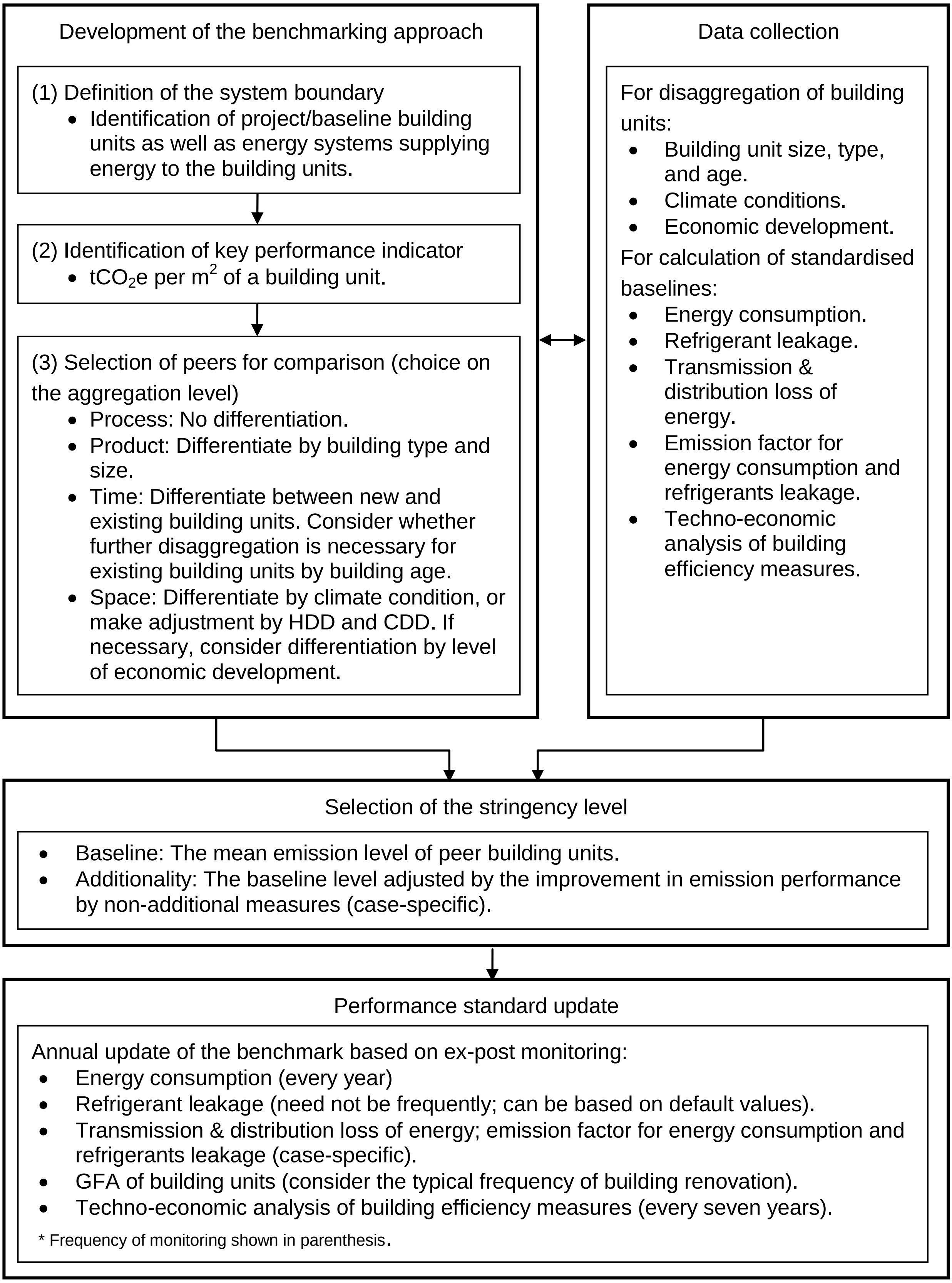

Figure 22: Flow chart of development of standard approaches to whole-building efficiency improvement projects

8. Case study II: Charcoal production

– Summary –

Improvements in the conversion of biomass to charcoal in Sub-Saharan Africa show a substantial potential for reductions in the associated GHG emissions. **The mitigation potential could be around 100 Mt CO_2e per year in this region alone.** It consists in both avoided consumption of non sustainable biomass and mitigation of CH_4 emissions during the production process. In Africa, over 20 Mt of charcoal are consumed per year. The strong and growing demand for charcoal fuel is an important cause of deforestation. More efficient charcoal production processes could decrease the wood consumption to 2.5 kg per tonne of charcoal**.** The identified ancillary benefits from more efficient charcoal production and reduced deforestation are huge and well understood.

CDM methodologies already exist for the mitigation of CH_4 emissions in charcoal production but have not lead to a significant number of projects, mainly due to the complex requirements of project specific data. **Standardised approaches can overcome the problem of high transaction costs incurred by the plant-specific data collection.** As a result, standardised approaches will likely enable the implementation of emission reduction projects which have previously been prevented. Ideally, the burden of baseline determination would largely be shifted away from project developers by establishing standardised factors.

Further data collection efforts are needed in order to derive the factors used in the standardised approach. These include among others the average CH_4 emission rate as well as the conversion efficiency of the kiln found to represent the most attractive course of action for the region. Additionally, a survey of technical and economical data collection should provide a clear answer on which technology can be considered as the baseline case with regard to the affordability to producers. **Most importantly, data collections on the share of non renewable biomass should be improved.** Due to the limited financial resources in host countries, international support with the right institutional framework is essential. An early start for financial support and additional surveys are needed in order to reduce the lead time.

Our recommendations on the key technicalities of the standardised approaches to charcoal production projects are summarised in Table 9. The proposed **standardised approach would lead to significant ease of the data collection burden on project developers**. The environmental effectiveness of the standardised approach is expected to be high because an appropriate stringency level for additionality determination can readily be set, and the proposed approach is conservative enough to avoid over-crediting of CERs. As **detailed disaggregation is not considered necessary** and **the replicability of this project type is high**, the standardised approach is likely to prove cost effective. The geographical distribution would be very positive as it can trigger projects in Sub-Saharan Africa, currently the most underrepresented region under the CDM. As further data collection efforts are needed, institutional capacity building and funding are essential.

Table 9: Summary of standardised approach to charcoal production projects

	Description
System boundary	Charcoal production site.
KPI	tCO_2e per TJ of charcoal produced.
Aggregation level	(1) Process: Not differentiated. (2) Product: TJ of charcoal – need to disaggregate inputs according to their sustainability (renewable biomass vs. non-renewable biomass). (3) Time: No need for differentiation between old and new as retrofit projects are highly unlikely – frequent update is not seen as critical. (4) Space: Similar socio economic conditions – mostly for LDCs in Sub-Saharan Africa.
Data requirements	Standardised baseline for specific greenhouse gas emissions per unit of charcoal: • Average efficiency of each charcoal kiln type. • Cost of various kiln types. • Sampling of financial resources of charcoal producers. • CH_4 emissions of kiln types. • Sampling of kiln types as share of the production. • Share of non renewable biomass used for the production of charcoal in the relevant region. Output of the project plant • Amount of charcoal produced (in volume or weight). • Specific heat content of the produced charcoal (per weight or per volume).
Stringency level	Baseline: • CO_2 emissions: Determined based on the "weighted average" of producers and the level of charcoal kiln efficiency they can operate. • CH_4 emissions: Weighted average for the region as there is no "most economically attractive course of action" for CH_4 emissions from pyrolysis gases – as there is no economic incentive for charcoal producers to reduce CH_4 emissions. These emissions are the result of both the technology and operating conditions. Additionality: • For CO_2 emissions: efficient technology which encounters an investment barrier. • For CH_4 emissions: any reduction below the average is seen as additional as there is no significant incentive for users to mitigate such emissions.
Updating frequency	Pluriannual update.

8.1 Relevance of the sector for standardised approaches

Charcoal is a widely used fuel in Sub-Saharan Africa, where most LDCs are located. Changes in the fuel mix have been observed in Sub-Saharan Africa (Seidel 2008). A significant share of households has shifted from unprocessed biomass such as fuelwood to more convenient fuels. Growing urbanisation along with changes in habits explains this shift to fuels which require less handling and gathering (Girard 2002). The shift to petroleum products such as kerosene and LPG has however been limited and an overwhelming majority of the energy supply in Africa still comes from wood[64]. This is mostly due to the limited affordability of petroleum based fuels for low-income households. Instead, charcoal has become one of the preferred fuels due to both its convenience and affordability (Girard 2002). Studies have confirmed this success of charcoal as the cheapest fuel per unit of energy[65] in Africa. In many parts of Sub-Saharan Africa, Charcoal has become the main domestic fuel, especially in urban areas (Kammen and Lew 2005).

The increased use of charcoal has raised major environmental concerns. Although charcoal can be combusted in a more efficient manner than wood, its production is inefficient. While 1 kg of charcoal has an energy content equivalent to 2 kg of wood, the production of 1 kg of charcoal commonly requires 6 kg of wood (Triffelner 2009). This means in turn that the increased use of charcoal has lead directly to a large increase in wood consumption (Kammen and Lew 2005) as roughly three times more wood is required per unit of biomass energy consumed. Along with agriculture, the production of charcoal is thought to be among the leading causes of deforestation in Africa (Greenresources 2010)[66]. The contribution of charcoal to deforestation is more obvious in places with scarce wood supply and strong demand for charcoal (Girard 2002). This is the case for example with forests surrounding centres of charcoal consumption such as cities. In Tanzania for example, out of the 420,000 ha of forest lost each year, around 100,000 ha of annual deforestation have been attributed to the production of charcoal (Mongabay 2005).

Producing charcoal more efficiently could significantly reduce GHG emissions related to its production:

(1) State of the art charcoal production processes can achieve primary biomass consumptions as low as 2.2 to 3.0 kg per kg of produced charcoal (Pronatura 2009). Switching from outdated production processes to efficient charcoal production processes could in turn save 5.5 kg of dry wood per kg of

[64] Pronatura suggests in its document that 89% of the energy supply in Africa still comes from wood (Pronatura 2009).
[65] The cost per household for shifting from charcoal to kerosene has been estimated to be an increase from $50 initially to $200 fuel cost per year (Triffelner 2008).
[66] In Africa, the leading driver for clear cutting of forests is still for livestock and agricultural purposes (Kammen and Lew 2005). In some cases charcoal is produced as a by-product of these forest clearing.

charcoal. With a conservative estimate[67] of a 50% carbon content in wood, the CO_2 savings from avoiding the use of non renewable biomass amounts to 8.25 kg CO_2 per kg charcoal.

(2) Optimised charcoal production can entirely avoid the emissions of CH_4 from pyrolytic gases resulting from traditional processes. Avoiding CH_4 emissions represents an emission reduction of roughly 3.5 tCO_2e tonne of charcoal (Pronatura 2009).

Considering a total charcoal consumption in Sub-Saharan Africa of 20 Mt annually (de Gouvello et al 2008) in 2003 and roughly 11.5 tCO_2e savings per tonne of charcoal (Pronatura 2009), the potential for emission reductions in the Sub-Saharan charcoal sector is between 50 and 200 Mt CO_2e per year[68], depending on the share of wood used for charcoal which is not sustainable[69].

It should be noted that while the relevance of charcoal as a domestic fuel and driving force for deforestation is high in Africa, it is of lower importance in other regions of the world. Efficient charcoal production in Africa is of key importance as there are many negative consequences of deforestation. These include, among others, the loss of biodiversity, land degradation, lower precipitations and water retention as well as a huge loss of economic potential. There is a stark contrast between the efficient supply of charcoal which can contribute to economic development by freeing time for fuel gathering and use and regions in which an unsustainable charcoal production has led to a shortage of fuel and construction material which hinders local development.

Existing CDM methodologies have so far not been able to incentivise the more efficient production of charcoal. The key constraint is the complexity in calculating emission reductions in charcoal production, through both (1) the reduction in CH_4-related emissions, and (2) the improved conversion (kg of charcoal produced per kg of wood) of non renewable biomass.

(1) CH_4 emission reductions: Complex procedures are required in AM0041 or AMS-III.K in order to determine the CH_4 emission factor in the baseline. These procedures require a rather high level of expertise. The use of simple procedures with default factors could greatly improve the usability of the methodologies.

(2) Energy efficiency improvement: No suitable methodology exists for the more efficient use of non renewable biomass by replacing inefficient installations with new, more efficient ones (other than for cookstoves). No procedure exists for establishment of the baseline level of efficiency of such installations.

[67] As a large share of carbon forests is stored not only in trunks and thick branches but also for example below ground, accounting only for the wood in deforestation represents a conservative approach.

[68] Previous estimates from the Food and Agriculture Organization (FAO) put the number of tonnes of wood annually cut at 100 million (Kammen and Lew 2005) – equivalent to 50 millions of tonnes of CO_2 annually (excluding pyrolysis CH_4 related emissions). As explained in the source used, the fuel wood cut for charcoal is likely to be larger than estimated.

[69] It is estimated that most of the charcoal used is unsustainably harvested.

A standardised approach could greatly simplify the baseline calculation in particular.

Details of existing applicable methodologies and their limitations are provided in the table below. Overall, **the complex procedures for baseline emissions calculation are the prime obstacle for charcoal projects.** It is thus essential to simplify these methodologies allowing the use of standard baseline factors.

Table 10: CDM biomass methodologies related to energy efficiency and/or CH_4 avoidance in biomass pyrolysis

Methodology	**Specificities and limitations**
AM0041 Mitigation of CH_4 emissions in the wood carbonisation activity for charcoal production.	Applicability: Only for reduced CH_4 emissions at existing charcoal kilns (no greenfield projects allowed – the methodology is not applicable to gains in energy efficiency. Data collection: Characterisation of the relation between yield and CH_4 emissions at the charcoal kiln in order to characterise the baseline function at the kiln before the project activity is implemented.
AMS-III.K. Avoidance of CH_4 release from charcoal production by shifting from traditional open-ended methods to mechanised charcoaling process	Applicability: New facilities (greenfield or replacement) to replace a specific plant or displace any outdated production capacity in the region - only for reduced CH_4 emissions at existing charcoal kilns (no gains in energy efficiency can be accounted for) – no switch in biomass type allowed. Data collection: Procedures to estimate the CH_4 emissions from charcoal production in "*open pit charcoal manufacturing process*" and "*brick based charcoal making processes*".
AMS-I.E. Switch from non-renewable biomass for thermal applications by the user	Applicability: Only for end users of small appliances using non-renewable biomass *(non applicable).* Stringent requirement that non-renewable biomass has been used since 31 December 1989. Data collection: Only vague procedure to determine the nature (renewable vs. non renewable) of the biomass.
AMS-I.C. Thermal energy production with or without electricity	Applicability: Only for "*supplying users with energy that displaces fossil fuel*" (thus non applicable to non renewable biomass in the baseline). *"Charcoal based biomass energy generation project activities are eligible to apply the methodology only if the charcoal is produced from renewable biomass sources* *(a) Charcoal is produced in kilns equipped with CH_4 recovery and destruction facility; or* *(b) If charcoal is produced in kilns not equipped with a CH_4*

	recovery and destruction facility, CH_4 emissions from the production of charcoal shall be considered. These emissions shall be calculated as per the procedures defined in the approved methodology AMS-III.K. Alternatively, conservative emission factor values from peer reviewed literature or from a registered CDM project activity can be used, provided that it can be demonstrated that the parameters from these are comparable e.g., source of biomass, characteristics of biomass such as moisture, carbon content, type of kiln, operating conditions such as ambient temperature." In turn the methodology is not suitable for the displacement of inefficient and carbon-intensive charcoal production. It could solely be applied in countries with a sufficient supply of biomass in new charcoal kilns whose production replaces fossil fuels. Data collection: n.a.
AMS-II.G. Energy efficiency measures in thermal applications of non-renewable biomass	Applicability: Mostly for appliances, especially cooking stoves (for which default factors are provided). The methodology is not applicable to CH_4-related emissions reductions. Data collection: n.a.

As of February 2010 an analysis of charcoal related CDM projects has identified a total of 16 projects at various stages. Of these projects only 10 are for applications other than power generation or the supply of industries. Out of these 10 projects, 7 have been found solely to target emissions from the pyrolysis gases (mostly CH_4) related to the production process of charcoal. These projects use either the approved large scale methodology AM0041 (Mitigation of CH_4 emissions in the wood carbonisation activity for charcoal production) or the approved small scale methodology AMS-III.K. (Avoidance of CH_4 release from charcoal production by shifting from traditional open-ended methods to mechanised charcoaling process). None of these 7 projects have been implemented in Sub-Saharan Africa. In total, 3 of these 7 projects targeting pyrolysis gases in the production of charcoal have so far been registered. The sole project found in Sub-Saharan Africa is the "Lusaka Project" in Zambia. This project is however not aimed at the transformation of biomass but at end-use substitution and energy efficiency. It applies the approved methodology AMS-I.E. and aims at replacing sustainably harvested small sticks in energy efficient cook stoves. This project has already been registered (Point Carbon 2010).

Standardised approaches could overcome the limitations observed in the existing methodologies, such as AM0041 and AMS-III.K, by providing standardised factors for the determination of the baseline. For project developers, the use of standardised factors will substantially reduce the complexity in the determination of baseline emissions. In order to maintain the environmental integrity of the approach, standardised baseline factors need to be stringent enough. The design of the approach and the decision on the stringency level will require expert judgement.
The following sections explain how performance standards can be established for charcoal production projects. The following key aspects of performance standards are discussed:

- System boundary: A physical boundary for accounting for GHG emissions..
- KPI: An indicator used for comparison of emission performance of the project against peers.
- Aggregation level: Criteria for identification of peers for the emission performance comparison. Four key dimensions are process, product, time, and space.
- Data requirements: Data required for the development of a performance standard, and availability of such data.
- Stringency level: The level of a performance standard for baseline emissions and/or additionality demonstration.
- Updating frequency: Required frequency for updating of a performance standard over time.

8.2 System boundary

As explained in the previous section, the system boundary for a standardised approach for low emitting charcoal production should include the whole production site. The approach specifically targets the efficient transformation of wood and possibly other types of biomass into charcoal.

For the sake of simplification, a standardised approach should not include end-users of the charcoal as the application of the charcoal is beyond the control of the project proponent. Charcoal is sometimes used in Africa for the cottage industry. Dedicated charcoal production for large scale industries should specifically be excluded from the standardised approach as it is not comparable to the small scale production of charcoal for domestic use[70]. Additional and separate energy efficiency measures at the end-user stage would still be possible in separate projects using adequate methodologies. This is the case for example with the distribution of efficient cook stoves. Such projects are not expected to conflict with the switch to a more efficient charcoal production.

Emission sources should at least include both CO_2 emissions and pyrolysis related emissions as their shares in the overall emission reductions are around 60-70% and 30-40%. Emissions related to the production of charcoal in the project should include (1) the emissions from sources of non renewable biomass, (2) additional energy use at the charcoal kiln such as auxiliary fossil fuels and electricity, and (3) emissions related to pyrolysis gases. Emissions from sources of non renewable biomass are the main emissions, and thus should be included. Emissions related to sustainable biomass should not be included. Emissions from auxiliary energy consumption are easy to monitor and should be included in the project for the sake of conservativeness.

[70] An identified risk for the inclusion of industries in the methodology is turning new users to charcoal as a result of the additional financial incentive, while its production is often not sustainable. Any approach should refrain from turning new users to charcoal in areas where it can potentially lead to deforestation.

As biomass related emissions include only non-renewable biomass, possibilities exist for switching from non renewable biomass to renewable biomass[71]. This is similar to other methodologies. This would for example include among other things (1) the switch to bio-residues which have not previously been used, (2) the switch to other types of biomass for which there is a sufficient availability for a sustainable supply, or (3) the sourcing of biomass from areas where it can be harvested sustainably[72].

One major question concerns the inclusion of Land Use Change and Forestry (LUCF) in the approach. A clear distinction can be made between LUCF activities and activities to reduce emissions occurring as a result of the transformation of the biomass. Thus it is recommended that the distinction between the two activities be maintained. Generally, it is thought that such projects can still be implemented in conjunction with the approach accounting for emission reductions at the charcoal kiln using the appropriate set of UNFCCC methodologies and tools. This allows the approach to be kept simple while making use of already approved procedures. Positive changes in carbon stocks from LUCF might occur if dedicated forest or dedicated plantation is established in order to supply primary biomass to charcoal production sites.

Finally, transportation might also play a role. Various reports have found that the supply of charcoal generally originates within a 50-200 km radius around consumption centres (Kammen and Lew 2005), with some exceptions in which charcoal is brought from over 300 km[73]. With a rough estimate of 100 g CO_2e per tonne-kilometre[74], emissions from transporting one tonne of charcoal are estimated at 0.01 tCO_2e per tonne for 100 kilometres. In comparison, savings from a reduced consumption of non sustainable wood are much larger. In turn, emissions related to the transportation of charcoal are only a minor source of emissions[75]. Therefore, they can be ignored in most cases.

In summary, **only a limited number of elements should be included in the standardised approach.** These are:

- The main emissions related to the production of the charcoal at the charcoal production site (including CO_2 emissions from energy use in the transformation as well as pyrolysis gas).
- Auxiliary fuel consumptions from the production of charcoal (electricity and auxiliary fuels).

[71] Such cases are thought to be rare - upon local depletion of one type of biomass, other types of local biomass would be used unless there is availability and affordability of fossil fuels instead.
[72] In this case, increased emissions from transportation should be accounted for.
[73] In some cases, charcoal has been transported to large cities from sites 350 to 1200 km away (Seidel 2008).
[74] For example a federal statistic in Canada indicated a trucking CO_2 intensity of 114 tCO_2 /t-km (CN 2010).
[75] Minor sources of emissions for CDM methodologies are defined as emissions accounting for less than 1% of the gross total.

Monitoring the consumption of auxiliary fuels is seen as uncomplicated as it can either be metered (electricity), measured or estimated from billing. The CO_2 emissions from the biomass conversion can be calculated based on the ratio of mass of charcoal produced and mass of biomass utilised. CH_4 emissions do not need to be monitored if the charcoal production unit is designed to avoid such emissions. New production units resulting in CH_4 emissions might not be desirable at all. For this reason, the use of the standardised approach could simply be limited to charcoal production units free of CH_4 emissions. As an alternative option, CH_4 emissions could be calculated in a conservative manner according to the prescribed formula in AM0041 or AMS-III.K. For larger units, they can be calculated on the basis of continuous monitoring using appropriate equipment.

8.3 Key performance indicator

Key performance indicators are typically expressed in emissions per unit of product. The product considered is charcoal. As both CO_2 and other GHGs are emitted in the process, emissions should be expressed in tonnes of CO_2 equivalent (tCO_2e).

The denominator used in the KPI should refer to the charcoal produced, expressed in an appropriate unit. It should be noted that the quality of charcoal can vary based on many parameters (e.g. temperature of operation, type of charcoal kiln, type of biomass used, etc.). For charcoal used as fuel the quality can be defined by its heating value. This heating value largely depends on the carbon content of the charcoal. Charcoals generally present carbon content of around 85%[76]. Comparing charcoals of different types would in turn require adjusting them to “standardised charcoal” by correcting for their heating value. For this reason it is more appropriate to express the product in unit of heat (TJ).

The resulting KPI should therefore be expressed as the sum of all emissions associated with the production of one terajoule (TJ) of charcoal per unit of charcoal:

$$\text{KPI}: \frac{[\text{tCO}_2\text{e}]}{[\text{TJ}]}$$

Under a simplified approach, the project emissions could be calculated as:

$$PE = EF_{elec,y} \times EC_{elec,y} + \sum_n (EF_j \times Q_j) + \sum_i \left(B_{i,y} \times f_{NRB,i,y} \times CC_i \times \frac{44}{12} \right)$$

Where:

[76] Typically charcoal processes operated at 500°C yield a carbon content of charcoal of 86% (FAO, 1987).

PE	=	Project emissions (tCO_2e/year)
$EF_{grid,\ y}$	=	Electricity emission factor in year y (tCO_2) *NB: A default value of 1.4 tCO_2/MWh can be used*
$EC_{elec,y}$	=	Electricity consumed by the charcoal plant in year y (MWh)
$EF_{,j}$	=	Emission factor of the auxiliary fuel j used (tCO_2/tonne)
Q_j	=	Quantity of auxiliary fuel *j* used in year y (tonnes)
$B_{i,y}$	=	Quantity of biomass from type *i* used in year y (tonnes)
$f_{NRB,i,y}$	=	Fraction of biomass of type i used in the absence of the project activity in year y that can be established as non renewable biomass using survey methods
CC_i	=	Carbon content of the biomass used. NB: For dry wood, the default value of 50% can be applied[77]

The baseline emissions could be calculated as:

$$BE = Q_{charcoal,y} \times NCV_{charcoal} \times EF_{BL,fuel,y}$$

Where:

BE	=	Baseline emissions (tCO_2e/year)
$Q_{\ charcoal,y}$	=	Quantity of charcoal produced at the site in year y
$NCV_{charcoal,y}$	=	Net calorific value of the charcoal produced (a default factor can be used if it can be ensured that the system properly yields a sufficient carbon content)
$EF_{BL,fuel}$	=	Emission factor for the baseline fuel (tCO_2/tonne)

This emission factor for the baseline fuel would be calculated as:

- For charcoal production sites supplying an area in which deforestation is occurring:

$$EF_{BL,fuel,y} = f_{NRB,i,y} \times SEF_{charcoal,CO2} + SEF_{charcoal,CH4}$$

Where:

$f_{NRB,y}$	=	Fraction of biomass used in the absence of the project activity in year y that can be established as non renewable biomass using survey methods
$SEF_{charcoal,CO2}$	=	Standard emission factor for the production of charcoal for CO_2 emissions (tCO_2/TJ)
$SEF_{charcoal,CH4}$	=	Standard emission factor for the production of charcoal emissions from pyrolysis gases (tCO_2e/TJ) *NB: This factor includes all emissions other than CO_2 (e.g. CO, N_2O and CH_4) which would have occurred in the baseline*

- For charcoal production sites at which an excess of biomass fuel is available and the use of domestic fossil fuel is observed:

[77] The number of 50% carbon content in wood is found in several sources (Pronatura 2009; Nabuurs et al. 2003).

$$EF_{BL,fuel,y} = SEF_{fossil fuel}$$

Where:

$SEF_{fossil\ fuel}$ = Standard emission factor for the baseline fossil fuel (tCO_2e/TJ)
NB: Without additional information the standard value of 63.0 tCO_2/TJ corresponding to the use of LPG can be used[78]*.*

8.4 Aggregation level

The processing of biomass is done throughout the African continent. In order to derive a standardised approach for baseline and additionality in Sub-Saharan Africa, it is essential to identify which level of disaggregation is needed. The following section discusses how the appropriate aggregation level should be determined for the four dimensions of aggregation.

8.4.1 Process aggregation

Many different technologies with different levels of efficiency have been observed for the small scale production of charcoal as found in Africa. Generally small scale processes should be considered, as they are the ones supplying most of the charcoal to be used as domestic fuel. Our literature survey did not find very large scale charcoal production lines in Africa for large scale users such as large industries or the power sector (other than in the CDM). Generally there is no reason to exclude large scale units provided that they sell charcoal to households and thus displace the small inefficient producers, and provided that their production does not specifically lead to additional deforestation by locally increasing the demand for charcoal (this would be the case if they supplied a large scale user).

No differentiation in the performance standard should be made based on the technology used as the final product is comparable and can be substituted. The objective is the substitution of small and inefficient/emitting production processes. Outputs can be comparable based on the heat content of the produced charcoal, expressed in TJ. The total heat content in the produced charcoal can be derived from the amount of charcoal produced as well as the specific heat content of this produced charcoal.

[78] In AMS-I.E. LPG and Kerosene emission factors as baseline domestic fuels are suggested. The use of 63.0 tCO_2/TJ from Kerosene in the baseline, instead of 71.5tCO_2/TJ for LPG, is more conservative.

8.4.2 Product aggregation

Charcoal is not a homogeneous product as the heat content per tonne of charcoal may differ. The specific heat content of charcoal depends not only on the type of biomass used but also on the process, with its parameters such as temperature and residence time. A standard unit of weight or volume of charcoal does not provide a good basis for an accurate comparison. Instead, **the comparison should be based on unit of heat.**

The key product differentiation should be by the inputs used for the production. Biomass inputs can not only be different in type but also in their moisture content and their sustainability. Wood is considered the reference input for the production of charcoal in the baseline. Any approach should however allow and be able to credit the switch to other types of biomass (1) which do not lead directly to deforestation, and (2) for which there is an observed surplus which ensures that their use will not lead to an increase in emissions outside the project activity. This is done by using the factor $f_{NRB,i}$ in the project, which accounts for the share of non renewable biomass in the supply of the biomass of type *i* to the market. For each type of biomass *i* which is not from renewable sources, it is important to know the carbon content CC_i as this value is proportional to the carbon emitted from its use. As types of wood show only minor differences in carbon content, however, a standard factor for wood could be used[79].

8.4.3 Temporal aggregation

As already mentioned it has not been observed that new plants have been built much more efficiently than existing ones without additional financing of some sort, mostly from environmental programmes and NGOs. As the goal is mostly to replace the existing production with a more efficient one, **the current level of performance including the least efficient plants should form the baseline.** The main change over time is expected to be in the renewable/non renewable nature of the biomass used (see Ch. 8.7).

8.4.4 Spatial aggregation

There are three possible reasons for spatial disaggregation when establishing a standardised approach for charcoal production:

(1) The geographical location of the charcoal production plant might influence its efficiency.
(2) The sustainability of the biomass used as input for charcoal production might be linked with the location delivering this biomass.

[79] Derived from several sources, including (Sampson 2002).

(3) The location in which the project plant charcoal is sold could determine which other sources of charcoal the project would displace.

It must be determined whether the above reasons are justified in the specific geographical area of concern.

(1) Geographical location and charcoal production efficiency

Our review of the literature found similar charcoal production technologies across Sub-Saharan Africa. If the average regional performance levels were to be slightly different, the same performance standards could still be used. Indeed no incentive for gaming has been found in this precise case, even with the same emission factors used in a larger region[80]. Therefore, **broadly applicable performance standards valid for many African countries could be used for both charcoal conversion efficiency and CH_4 emissions from the pyrolysis process.**

(2) & (3) Geographical location and sustainability of biomass and/or type of charcoal currently in use

The origin and destination of each type of biomass processed into charcoal are thought to be key parameters for the level of emission reductions from a more efficient production of charcoal.

Indeed, the share of non sustainable wood sources in the supply of biomass for the production of charcoal can show some strong regional differences. This means that the same increase in the efficiency of the charcoal production process will not lead to the same amount of avoided consumption of non-sustainable biomass. As found in the literature, essentially two cases can be distinguished regarding the situation of the biomass produced (Kammen and Lew 2005): (1) the biomass supply is in excess and the more efficient production of biomass can replace fossil fuels (mostly LPG and kerosene), or (2) the biomass is harvested too intensively with deforestation as a consequence.

Spatial disaggregation might also be required according to the area in which the charcoal is sold. Charcoal produced from renewable wood in region A and sent in the form of charcoal to users in region B can still lead to substantial emission reductions if the baseline case would have been the use of non sustainable biomass from region B for charcoal production. In turn, such a project should also be able to apply the same baseline as found for charcoal from biomass sourced in region B. Such a project would lead to emission reductions from the replacement of non renewable biomass by renewable biomass.

[80] It is reasonable to think that new charcoal kilns would avoid areas where they would be exposed to the competition of more modern and lower emitting kilns while the baseline emission factor is standard – this would lead to a conservative adjustment.

It has indeed been observed that, as the fuelwood supply becomes scarce, charcoal transportation distances increase. While the usual supply of charcoal is found in the range of 30 to 250 km from urban centres, transportation over 1000 km has also been observed (Kammen and Lew 2005). In turn it makes sense for a standardised approach to take into account the possibility of switching the region from which the biomass input is sourced.

To conclude, **the basis of spatial aggregation for the baseline should be the availability of biomass in the area of consumption.** Different cases are summarised in the following table.

Table 11: Implications of an efficient production of charcoal – fuels displaced by saved biomass

Availability of biomass wood	Production of charcoal from generic wood supply	Production of charcoal from dedicated forest plantation
Limited and decreasing – fuelwood crisis	Emission reductions from reduced CH_4 emissions (pyrolysis). Emission reductions from saved non renewable biomass.	Emission reductions from reduced CH_4 emissions (pyrolysis). Emission reductions from saved non renewable biomass. *NB: It has to be ensured that the dedicated plantation does not displace agricultural and pastoral activities.*
Close to balanced	Unknown.	Unknown.
Oversupply well established	Emission reductions from the replacement of fossil fuels (probably kerosene or LPG) by renewable biomass[81]. No emission reduction from CH_4 should be credited as the baseline is the use of fossil fuels.	Emission reductions from the replacement of fossil fuels (likely, kerosene or LPG) by renewable biomass. No emission reduction from CH_4 should be credited as the baseline is the use of fossil fuels. Additional emission reductions could be claimed from A/R activities.

8.5 Data requirements

Monitoring parameters

Aggregated data would be required for the baseline while plant specific data would be required in the project. Data required for the project can be represented in the following diagram also summarising the point of monitoring.

[81] As found in AMS-I.E.

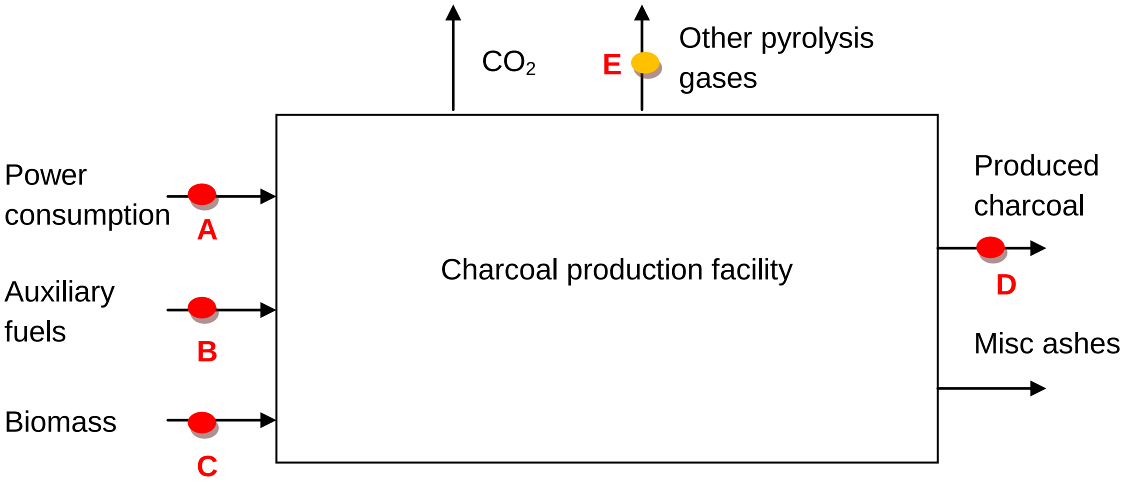

Figure 23: System boundary and monitoring points for charcoal projects

Table 12: List of key monitoring parameters and respective points of monitoring

Monitoring point	**Data to monitor**	**Type of monitoring**
A	Power consumption Emission factor *(not monitored)*	Direct and continuous metering of power consumption (MWh). For the project electricity emission factor, a conservative assumption can be used (e.g. 1.4 tCO_2/MWh).
B	Quantity of auxiliary fuel consumption Emission factor of auxiliary fuels used *(not monitored)*	The quantity of auxiliary fuels consumed can be taken from stock inventory and checked against billing. The emission factors can be taken from standardised emission factors.
C	Quantity of biomass *i* Fraction of non renewable biomass for biomass type *i* $f_{NRB,i,y}$ Carbon content of biomass *i*	The quantity of biomass *i* used in the production of charcoal is monitored by gravimetry. The fraction of non renewable biomass for the type of biomass *i* will be determined either top down by a study or by the project proponent. The carbon content for each type of biomass *i* can be taken directly from available sources of literature (IPCC or others). A conservative value should be available for non listed types of biomass as a fallback option.
D	Quantity of produced charcoal fuel $Q_{charcoal,y}$ Net calorific value of the	Monitoring per gravimetry of the amount of charcoal produced (tonnes). Monitoring of the specific heating value of the

	produced charcoal $NCV_{charcoal,y}$	charcoal produced can be done by either (1) direct sampling and analysis, or (2) calculation as a function of the pyrolysis parameters, such as time and temperature, applied for specific biomass types.
E	Emissions of other pyrolysis gases, especially CH_4 emissions	None if the system can prove by its design that it does not lead to significant emissions from pyrolysis gases (less than 1% of the total GHG emissions). Continuous monitoring is possible but more expensive. A monitoring of parameters for which a clear correlation with CH4 emissions can be established can be used instead, as with approved methodologies AM0041 or AMS-III.G. (e.g. CH_4 specific emission factor as a function of the pyrolysis temperature).

Data availability

Data on the CH_4 emissions from pyrolysis gases are quite difficult to derive as the specific CH_4 emissions per produced tonne of charcoal depend on the technology used and operation characteristics. However, a fair amount of data already exists and could be used. Values for emissions of pyrolysis gases are already available from the following:

- PDDs developed under the two dedicated methodologies AM0041 and AMS-III.K.
- Miscellaneous sources of literature.
- As a back-calculation applying methodologies found in the literature, where it is for example a function of the yield (tonnes of charcoal yield per tonne of biomass used).

It must be ensured that meaningful and representative data are used to derive an adequate standardised baseline emission factor for Sub-Saharan Africa. Values are found mostly in a range from 0.6 to 1.0 tCO_2e per tonne of charcoal produced. Further work is needed in order to determine the exact performance standard to be used in the baseline.

Data required for the choice of a baseline emission rate of CO_2 from produced charcoal include three key parameters: (1) the efficiency of the conversion of biomass to charcoal, (2) the carbon content of various types of biomass used, and (3) the share of non renewable biomass.

- There already exist appropriate standard carbon contents for various common types of biomass.
- Data on the efficiency of the conversion of biomass to charcoal is partly available in the existing literature. It is probably not realistic to perform an in-depth survey to monitor the performance of each small kiln available in the

region. Instead, a conservative enough standardised factor can be used per technology.

- The share of non renewable biomass for each type of biomass *i* should be determined for the main types of biomass throughout target countries in Africa. The most obvious type of biomass to be surveyed is wood, especially types which are traditionally used in the production of charcoal. Publications of national forest inventories and deforestation rates could be useful for the calculation of the share of non-renewable biomass used. A top-down survey would largely eliminate the risk for gaming. Project proponents would still be able to use other types of surplus biomass in the geographic area using an approach similar to that of ACM0006.

So far, only a limited amount of data is available for assessing the additionality of new charcoal kilns. Therefore, **further efforts would be required in data collection on the cost of various charcoal kilns as well as the financial resources available for charcoal producers.**

8.6 Stringency level

Stringency level for baselines

Greenfield plant vs. retrofit: There is a need to avoid crediting efficient charcoal kilns for their continued BAU operation. For this reason any approach should select for the baseline the lowest emission factor of either (1) the standardised baseline performance (not differentiated between greenfield plants and retrofit) or (2) the current plant performance based on the continued operation of the plant. Crediting of non-additional charcoal production can be excluded using one of the following approaches:

(1) Use the lowest of the standardised common baseline emission factor or the technology specific baseline factor in case a technology more efficient than the average is already used. This would only require the characterisation of the baseline technology at the site.

(2) Mandate a substantial investment for the project which should materialise in a switch toward a new technology with the scrapping of the original installation.

(3) Simply exclude any retrofits from the approach and only allow for the construction of new plants.

Generally, mitigation potential through retrofit of existing plants is very limited in Sub-Saharan Africa. Most of the charcoal plants in Sub-Saharan Africa are micro- to small-scale ones. Thus, only a limited number of the existing plants can be retrofitted in a technically and economically rational manner. As there is no large potential for retrofits to be implemented, there no major interest in creating an incentive for such retrofits. Therefore, **differentiation between new and existing plants is necessary.**

Differentiation based on biomass sustainability: The key requirement for differentiation is the availability of biomass according to which the efficient production of charcoal will either reduce the demand for unsustainable biomass or replace fossil fuels which would otherwise have been used. Where charcoal replaces a fossil fuel, the approach is generally very straightforward as the fuel replaced will in all likelihood be the fossil fuel most affordable to end users. This is justified by the fact that the literature shows that the single largest factor hindering the switch to fossil fuels for domestic use is their affordability.

Specific levels for pyrolysis related emissions: The stringency level to be selected in the baseline for the standard emission factor for the charcoal consists in two elements: firstly the efficiency of the conversion of non renewable biomass, and secondly the associated CH_4 emissions from the pyrolysis. For new plants the most economically attractive course of action will determine the level of performance expected from the baseline for both the emission of pyrolysis gases and the efficiency of the conversion from biomass to charcoal. There is however generally no economic incentive to reduce the pyrolysis gases other than climate protection[82]. As the incentive to abate CH_4 emissions from pyrolysis emissions is negligible, even newer and more modern plants such as the Plantar project in Brazil show a CH_4 emission baseline in line with those of the studied earth mound kiln in Kenya, which is among the least efficient types worldwide (Table 13). Thus the most economically attractive course of action regarding CH_4 emissions is a continued level of emissions for new plants. In the absence of the CDM present levels are generally expected to continue.

For this reason, a number as close as possible to the weighted average of specific CH_4 emissions of production might be suitable. From our review of the literature many technologies and operating practices can be found in Africa. However, these technologies are the same throughout the whole continent, perhaps only with different levels of diffusion.

Several options exist for a standardised baseline for CH_4 emissions:

(1) Perform measuring campaigns at all sites: This option is not realistic due to the workload it represents. Additionally, for kilns for which CH_4 depends upon operating conditions, a continuous monitoring of operating parameters would be required for all kilns.

(2) Perform a sampling monitoring for different technologies and use the average: This procedure could be acceptable for small scale methodologies but can be inaccurate, as production capacity is not evenly spread among technologies. Thus, knowledge of the share of each technology would be needed.

(3) Perform a sample monitoring for different technologies – perform a second sampling to determine the share of each technology in the weighted production capacity – and multiply the performance by the weighted

[82] It should be noted that the emissions of such gases for many kilns types is a function of the efficiency with lower CH_4 emissions for higher efficiencies

production capacity of each type of technology: This approach is considered more complicated but feasible, justifiable and quite accurate. The weighted average of the performance will determine the baseline for pyrolysis related emissions.

(4) Derive numbers from the existing literature and apply them: Without an accurate knowledge of the distribution of the production capacity per type of technology, this approach might be seen as too arbitrary. Reviewing the literature, a certain spread in numbers used as a baseline for CH_4 emissions from charcoal consumption can generally be observed (Table 13).

Table 13: CH_4 emission factors for charcoal production

CH_4 emissions per tonne of charcoal	Source
3.5 tCO_2/t charcoal (average value between the least efficient carbonisation methods in Sahelian regions (which constitute the common practice in the baseline) and the value used in the Plantar project, where improved charcoal kilns are used)	(Pronatura 2009)
0.997 tCO2e/t charcoal (based on regression analysis for the baseline Plantar production of an emission factor of EF=140-(314*yield) expressed in kg CH_4 per t charcoal – equivalent to 47.5 kg CH_4 per t charcoal for a yield of 29.2% or 0.292 tonnes of charcoal per tonne of dry wood)	Plantar project (PDD under AM0041)
0.777 tCO_2e/t charcoal (equivalent to 0.037 tCH_4/t charcoal).	(Amous 1999) 6.1.1 "Conversion and Emission Factors"
0.63 tCO_2e/t charcoal (based on 1000 kg CH4 per TJ of charcoal produced and 30 GJ/t charcoal)	(Reumerman and Frederiks 2002)
0.67 to 1.30 tCO_2e/t charcoal (based on 32 to 62 kg of CH_4 emitted by various kilns in Kenya and Brazil)	(Pennise et al. 2001) Note that this study is of high relevance as the tested technology, the earth mound kiln, is widely used in Sub-Saharan Africa. For example in Kenya, over 90% of producers use this technology (Seidel 2008)

Generally, option 3 is considered the most likely and robust option from which to derive numbers. The data collection should exclude any kiln equipped with CH_4 recovery or flaring as the purpose of such a measure can be regarded as almost solely climate protection, and thus is not representative of the baseline.

Specific levels for emissions related to the conversion of non renewable biomass: For new plants, the level of stringency of standardised baselines should reflect the most economically attractive course of action, taking into account barriers which prevent the implementation of various scenarios. A lack of capital is one of the main barriers, especially in countries where monthly income per capita is less than €50. Even low cost charcoal kilns such as basic steel kilns with a capital requirement of €700[83] are too expensive for most producers (Seidel 2008). As such it should be taken into account that a certain share of producers will not be able to shift to more efficient kilns. In turn the baseline representing the most attractive course of action might be valid only for a number of producers with access to some capital.

Overall, **we conclude that deriving figures will require surveying the economic activity and possibly the capital availability of producers on the ground.** Another survey or review of the literature would need to explore the cost of different kiln types. In turn, a stringent and reasonable assumption for the baseline would be the use of the most efficient kiln available for the level of potential capital availability. For each technology, the average level of operational efficiency can be used[84]. The resulting global performance standard would be a weighted average of the performance available for the weighted average of capital availability of producers.

In reality, not all producers operate the best kiln they could reasonably operate given their access to capital. Other parameters should therefore also be taken into account. For example, charcoal kilns built with additional financing (e.g., NGO, ODA, carbon finance, etc.) should be excluded from the sample. Additionally, technologies not having reached a meaningful penetration rate for their affordability class should not be taken into account[85]. An example of this diffusion rate could be 10% of the production tool added or replaced over the last 5 years in the relevant market, as found in US offset programmes.

Overall, the approach proposed is conservative for several reasons:

- The CO_2 savings associated with the avoided deforestation are larger than those of the approach in which only non renewable wood is used for calculating the savings.
- Producers with the lowest efficiency and thus the highest emissions per tonne of charcoal are the ones likely to be replaced first by the most efficient production capacity.

It must be noted that the approach taken can in theory be set either specifically for an area or as a standardised factor for a larger region which can even include several countries. Due to the need for an in-depth study with a subsequent treatment of the data to adjust for the most efficient technology which can be found in the class of capital availability, a baseline factor valid for a broader region would greatly reduce the survey cost.

The goal of the survey, and the subsequent data processing based on the capacity to afford specific technologies, is to derive the average yield for the baseline kiln. Once

[83] Converted from $1,000.

[84] A further differentiation taking into account measured operation parameters of local plants would complicate the approach to the point that most elements of standardisation would be lost.

[85] This is the case for example with the Adam-retort kiln which despite a low cost of only $300 to $400 and efficiency as high as 40% is only at a pilot phase (Seidel 2008) – its diffusion is uncertain due to the skills required for its operation.

this value has been calculated, the standard emission factors for the production of charcoal $SEF_{charcoal}$ can in turn be calculated. It is expressed in CO_2 emitted from the charcoal production process per TJ of charcoal heating fuel produced from non renewable wood. As charcoal quality varies, the carbon content or heating value of charcoal differs. The survey of charcoal production needs to take into account the difference in charcoal quality in order to enable a fair comparison.

Stringency level for additionality testing

Establishing additionality would require consideration of two key elements. First, a certain performance threshold needs to be established to prove that the project clearly deviates from what is seen as BAU. If the CDM is to play a meaningful role in incentivising the establishment of new efficient charcoal kilns, the performance has to be notably higher than the baseline. A stringent additionality level is considered appropriate, as very efficient technologies have been developed recently. Such technologies are almost free of any CH_4 emissions and show a yield between 0.35 to 0.45 tonnes of charcoal per tonne of fuelwood (Pronatura 2009).

Second, a survey is necessary to show that there are indeed inefficient plants supplying the local market. It has to be proven that there is a possible gain in the efficiency of conversion from wood to charcoal which can contribute to the decrease of deforestation. This could be established solely on the basis of the observed production capacity in the region without specific numbers.

The level of additionality would typically be based on kilns which are already found in Africa, such as the Casamance kiln and the Steel kiln, which have a higher efficiency but have not been more widely used due to their lack of affordability. The yield[86] for those kilns is in the range of 27 to 35% (Seidel 2008) for various steel kilns and 25 to 30% for the Casamance kiln (Kammen et al. 2005). With a carbon content of 50% in wood and 85% in charcoal, this is equivalent to an emission factor of 6.1 tCO_2 per tonne of charcoal.

Due to the lack of economic incentive, CH_4 abatements for charcoal kilns are additional, an average CH_4 emission factor could be used. Based on Table 13, the value applied could be the average of the range of emission factors observed, i.e. 0.6-1.0 tCO_2e per tonne of charcoal produced. Additional steps would need to narrow down this range and provide a simple procedure to derive a precise and conservative enough value for baseline CH4 emissions from pyrolytic gases.

8.7 Updating frequency

$SEF_{charcoal}$ (Standard emission factor for the production of charcoal): There is generally no large need for updating the specific emission factor for charcoal

[86] The yield of a charcoal kiln is defined as the mass ratio between the charcoal produced and the wood used for its production.

production. It has been observed in the literature that the charcoal industry in Africa is overwhelmingly artisanal[87] and answers the needs for subsistence (Seidel 2008). So far, no large scale investment in new equipment has been observed other than for environmental purposes (either against deforestation or against related emissions or both). These investments have mostly been supported by public actors, whether national or international. No large scale investment in more modern charcoal production can be expected on a "for profit" basis without the CDM as producers lack the required capital (Kituyi 2004). In turn this parameter is expected not to change or to change only in a minor way and could safely be fixed ex-ante based at the point of time of the decision to implement the CDM. The stringency level of $SEF_{charcoal}$ could be revised after a long period of 3 to 5 years based on a new field survey to estimate the performance of units used for the determination of the baseline.

$f_{RNB,I,y}$ (Fraction of biomass used in the absence of the project activity in year y): Generally, types of biomass which are renewable do not change suddenly. The most likely change is from a sustainable supply of biomass to an unsustainable supply of the biomass type due to its depletion. The chances of having an unsustainable biomass supply turn sustainable without external support are very low. Thus, a low frequency of updating is more conservative. It could be sufficient to conduct a survey once for the whole crediting period of the project. New studies would only have to be undertaken, ideally on a top-down basis, once the new modern production capacity installed under the CDM (as well as other environmental programmes) has reached a level at which most of the inefficient production processes in the specific region are considered to have been replaced.

8.8 Implications of the standardised approach

Environmental effectiveness

The environmental effectiveness of the standardised approach hinges on whether a performance standard can be set at the right level of stringency. It has been observed that the deployment of more efficient technologies to produce charcoal in Sub-Saharan Africa has almost always been done as a result of national or international support. Without external support, only artisanal types of production processes have been implemented. This is especially the case in the poorest countries with extremely limited financial resources[88]. A standardised additionality level does not need to be much more stringent than the present average performance in order to exclude projects which would have been implemented anyway. Production processes more efficient than the market average are not

[87] The observed scale for most producers is of batches of 1 to 5 tonnes (Kammen and Lew 2005) in earth, brick or steel drum kilns.

[88] Despite its huge negative impact on their economic potential, potential host countries have not been able to halt this deforestation, highlighting the additionality even taking into account the case where the project is undertaken by a public entity (which would be able to reap ancillary benefits from halted deforestation).

implemented autonomously. Thus, the most economically attractive option would very likely be a charcoal production process with a low efficiency and with no abatement of CH_4 emissions.

Legal requirements have sometimes been put in order to stop inefficient charcoal production. However, such laws have never been successfully enforced and have just led to an illegal continued charcoal production. According to a CDM rule, national laws in place do not need to be taken into account in the determination of project additionality if the enforcement rate does not exceed 50% in the region[89]. This means that the regulations in Sub-Saharan Africa “currently” do not need to be taken into account[90].

The above concludes that **a stringency level set at the current common practice level would be a reasonable threshold for baseline emissions and additionality demonstration.** Due to the fact that deforestation reduces the carbon stock not only in the trunk and branches of trees but also below the ground level, the project is expected to result in substantial emission reductions that are not credited at all. This conservativeness helps ensure the environmental integrity of the standardised approach.

Cost effectiveness

The standardised baseline could be further differentiated by type of biomass used, country, amount of moisture in the biomass, local composition of the production process, etc. This would however increase the cost for setting up the approach without increasing the overall environmental integrity. **A single standardised baseline per country or even valid for a group of countries can be envisioned.** More importantly, clear definitions of areas which are suffering from deforestation tied to the use of charcoal should be established. As the product is roughly the same, no technology specific performance standards should be set. Only technologies having demonstrated that they guarantee a very low CH_4 operation should be eligible, unless the project proponent accepts the complex characterisation and additional monitoring of its production[91].

The overall cost of developing a standardised approach is low compared to the market value of the emission reductions it could achieve under the CDM. Taken as a whole, setting up a standardised approach for emission reductions could require considerable upfront financing. This upfront financing could however lead to substantial emission reductions. For example, an upfront cost of €1 to 10 million for the approach represents only €0.01 to 0.10 per CER generated if only 10 million

[89] The 50% compliance rate ruling refers to what has been accepted in the methodology of AM0012 and since then in several other methodologies.
[90] This may change in the future. Hence an enforcement rate of relevant regulations needs to be monitored over time.
[91] For example in production where CH4 emissions are a function of temperature, an initial characterization of the CH4 emissions as a function of the temperature, and monitoring of the temperature, are necessary.

CERs[92] per year were to be issued. Thus the cost of developing a standardised approach to charcoal production has to be compared with the direct benefit of tapping the mitigation potential.

Additionally, co-benefits for the host countries should be taken into account. Significant co-benefits can be expected in economic development, environmental protection, energy and food security, etc. For example, the following co-benefits from an efficient production of charcoal have been identified:

- Potential for further economic use of forests with a stopped depletion (e.g., selective logging or agro forestry).
- Increased predictability of income generated from charcoal production activity in Sub-Saharan Africa[93].
- Reduced desertification and increased biodiversity from reduced deforestation.
- Improved energy access, as charcoal is the cheapest of all commercial fuels in Africa.
- Improved gender equality, as most of the cooking is performed by women and wood cooking requires much more time than charcoal cooking.
- Reduction of indoor air pollution, as the combustion of charcoal produces less fumes by far than fuelwood.

Distributional considerations

This project type is aimed at Sub-Saharan Africa where most LDCs are located[94]. Charcoal does not play a major role as a domestic fuel in other parts of the world except in Latin America, where it is also used for large scale industrial applications and the energy sector. The approach is expected to be able to improve the distribution of CDM projects. If no differentiation is made for biomass moisture content in the baseline, the distribution might slightly favour more arid areas. Also, more charcoal might be produced locally in areas with greater availability of biomass and transported to places with a strong demand for and a lasting deficit of available domestic biofuel. This means that **the geographical distribution of CDM projects is likely to favour rural areas with forestry resources within a certain radius from the consumption centre.** This is similar to the present situation. A notable exception could be the transportation of charcoal from regions with a sufficient supply of biomass to Sahel regions which have already exhausted their biomass. **On project size distribution, a shift towards slightly larger charcoal production**

[92] This is a conservative assumption, as the potential for emission reduction from a more efficient charcoal production in Africa has been estimated between 50 and 200 million tCO_2e.
[93] The charcoal sector in Africa might represent as much as $350 million per year (Seidel 2008).
[94] In order to be relevant to other countries and bring the same benefits, charcoal would need to be a key fuel for a large share of the population, and this would need to be combined with high deforestation in which charcoal plays a key role due to the low conversion efficiency of biomass into charcoal. While this situation is encountered in Africa, it is unknown at this point whether other countries are also suitable for the approach. Nepal, which has both need for cooking/heating fuel and substantial deforestation, could be one possible candidate for the standardised approach outside Africa.

units may be observed. Highly efficient units can already be built for a scale of just 3 to 4 tonnes of charcoal production per day.

Institutional capacity

Institutional capacity is considered high even if the appropriate expertise does not always exist in host countries. Institutions such as the FAO have sufficient expertise in identifying areas of deforestation and/or verifying the standardised approach. There is moreover a strong willingness from Annex I countries to develop the CDM in Sub-Saharan Africa, fight deforestation and poverty and contribute to local economic development by lowering energy poverty. Consequently, initial funding could easily be gathered from individual countries, international institutions or multilateral fund.

8.9 Recommendations for further work

The next steps for further development are summarised in Figure 24. In particular, the following steps would require major efforts. First, **evaluate the biomass sustainability** on a regional or national level starting with areas which have been identified as being the most exposed to deforestation. For example, national forest inventory and deforestation baselines can be used for the approach if such data is publicly available.

Second, perform a literature review to **collect and validate figures on the carbon content of the most common types of biomass** used in Africa for the production of charcoal.

Third, carry out a survey to **collect data on the level of CH_4 emissions from the pyrolytic gases** from the conversion of biomass into charcoal. This encompasses the following two main tasks:

- Collect information on CH_4 emissions for each type of kiln used with a sufficient number of samples to characterise each technology, e.g., 5 to 10 kilns of each technology should be sampled. Figures already available in the literature can be combined with the sampling study.
- In order to calculate the weighted average for these emissions in the existing production capacity, a sample of the respective technologies should provide data on the share of the cumulative amount of charcoal produced by each technology in the region. In the absence of observed large differences, all of Sub-Saharan Africa could be used as the relevant region.

Fourth, conduct a survey to **determine the level of efficiency of the conversion of biomass into charcoal for each technology.** A procedure should be established that ensures a fair and comparable assessment of every technology.

Last, **perform a technical and economical study in order to determine the technology which represents the baseline.** Such a study would need not only to assess the cost of different charcoal production technologies but also to provide information on their affordability. Such a survey would need in particular to record financial information from charcoal producers and assess the barriers which have prevented the switch to more efficient technologies, if this switch is economically affordable to the producer. This study on the cost of kilns and the affordability of kilns to charcoal producers should be backed by a meaningful collection of qualitative and quantitative data representative of the geographical region concerned.

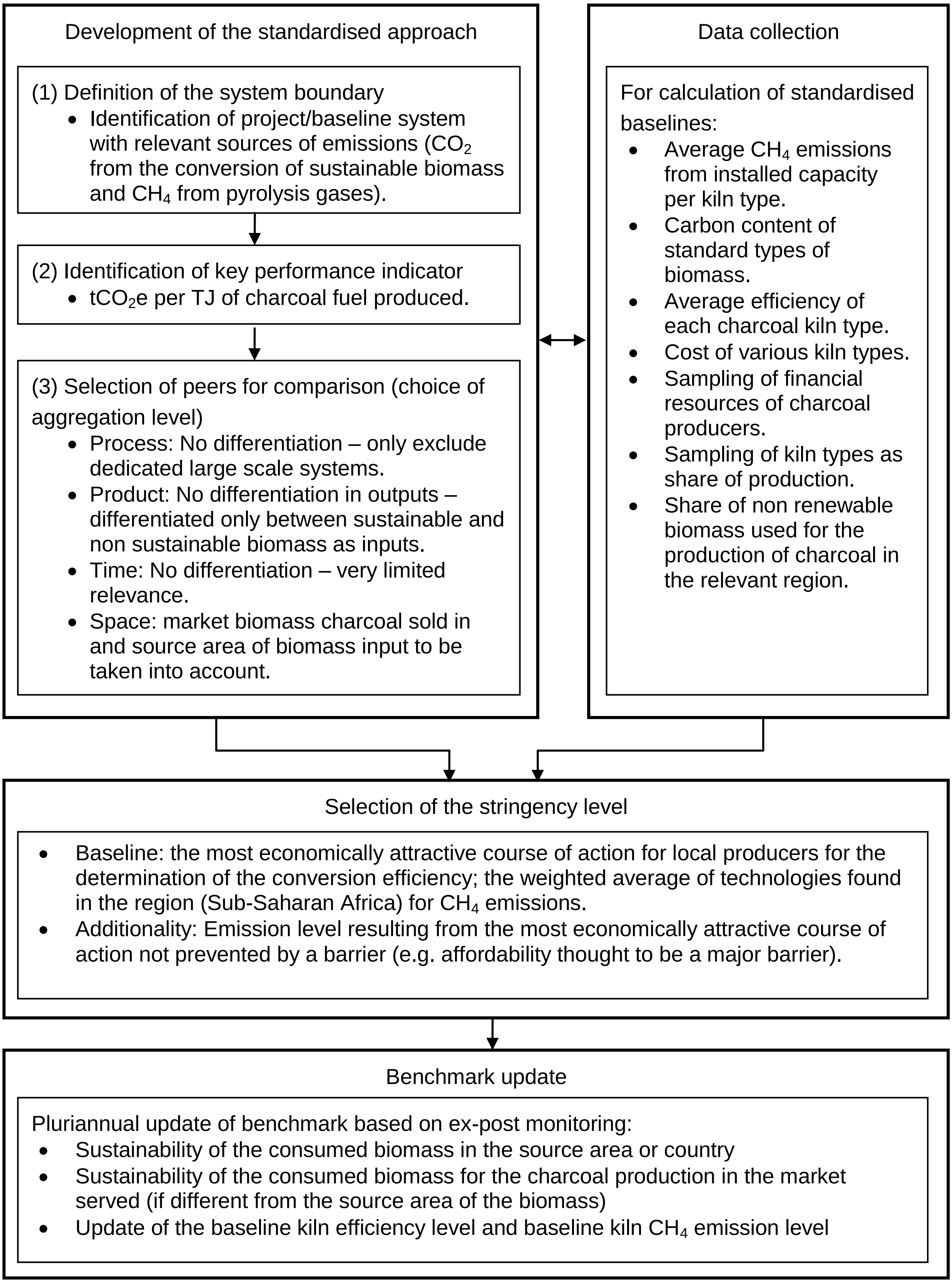

Figure 24: Flow chart of development of standard approaches to charcoal production projects

9. Conclusions

A greater use of standardised approaches has been proposed as a means to standardise the currently complex and often subjective process of CDM baseline setting and additionality demonstration. Removing some of the operational burden and transaction cost from CDM project developers is seen as an opportunity for scaling up the CDM in countries whose participation to date has been limited. Although it is a relatively new instrument under the CDM, the standardised approach based on an assessment of relative performance has already been widely used throughout the world for comparison of energy and/or emission performance of companies. The key technical aspects that are critical to the success of the standardised approach are: **(1) level of aggregation, (2) data requirements, (3) stringency level, and (4) updating frequency**. The level of aggregation is further differentiated in the following four dimensions: process, product, time and space.

The experience gained with the existing performance comparison initiatives worldwide shows some convergence in methodological approach. First, performance standards are commonly set on **a product or service-specific basis.** Second, **separate performance standards are usually set for new and existing installations.** On the other hand, key differences are observed in the treatment of technological differences and the choice of stringency level of performance standards. US initiatives have tried to assess additionality using **a standard emission rate, specifications on technology or practice, or a market penetration rate threshold.** However, the reliability of this approach has not yet been evaluated independently. Though experience to date already gives important insights, further harmonisation of methodological approaches is required for wider application of standardised approaches to the CDM.

Choosing a credible stringency level for performance standards based on the right set of peers plays a decisive role in the effectiveness and efficiency of standardised approaches. This requires, among other things, a balanced choice of the aggregation level of a performance standard, an in-depth assessment of the key parameters that would influence the additionality of projects in a sector, and detailed technical and economic analysis of technology options available in the sector. **There is a large body of objective data available that can inform decisions on these technical aspects.** Also essential is regular updating of performance standards in order to reflect autonomous technological progress over time.

CDM performance standards are feasible, but require an improvement in data collection, the early set up of adequate institutions, and the development of specific approaches for the choice of performance indicators and stringency levels for the selected indicators. Data collection efforts which could be used by the CDM are already underway but need to be scaled up. New data collection should be started as soon as possible for additional key sectors. This requires substantial international upfront financing. **Approaches for indicator choice and proposals regarding**

stringency levels could be developed by a Standardised Approach Coordinator (SAC), with the CDM Executive Board (EB) taking the final decisions on the standardised approaches. As setting of performance standards will require between one and four years, parties should immediately agree on this approach to make it operational by 2013. A preliminary cost estimate of the development of a performance standard covering 200 plants is €1.2-4.5 million, assuming one-year monitoring for the data collection. If the data already exist, the cost would be €0.2-0.5 million. The necessary financing could initially be taken from the accumulated surplus of the CDM EB (currently around $40 million). Development of standardised approaches will be complex and need to be tailored to each sector. Industrial expertise has to be harnessed, but gaming of the indicators by industry interests needs to be avoided.

In general, sectors amenable to standardised approaches produce outputs or services similar in their nature and in their production processes. Sectors ideal for standardised approaches would tend to be highly concentrated, with limited geographical factors affecting the level of GHG performance, and already have a large amount of data available for assessing relative performance. Therefore, **standardised approaches are likely to be a suitable instrument for large, homogeneous sectors.** For other sectors not amenable to standardised approaches, alternative approaches (e.g., default parameters) have to be considered as a fall-back option.

The environmental effectiveness of standardised approaches depends primarily on their level of stringency. The more stringent a performance standard is, the more likely that non-additional projects will be weeded out, but at the same time fewer projects will be able to beat the performance standard. Setting the “right” level of performance standards requires a high degree of confidence in the efficiency or carbon intensity distribution curves of business-as-usual (BAU) projects. Where this is not possible, alternative approaches (e.g., project-specific additionality tests or credit discounting) would need to be pursued.

Cost-effectiveness is strongly influenced by the number of performance standards to be established. An important trade-off exists between the simplicity and the stronger investment incentives for low-carbon technologies given by a single standardised approach using a single performance standard, and the opportunities for performance improvement by high-carbon technologies provided by performance standards differentiated by technology. In order to make the approach workable, performance standards should be set in a product or service-specific, technology-neutral manner. However, stringency levels for baseline and additionality should be differentiated between new and existing installations, possibly differentiating according to vintage classes, so that sufficient incentives for improvement are given to existing installations.

If the standardised approach becomes a voluntary option, project developers would have a choice between a presumably stringent performance standard and a project-specific baseline. This would provide positive incentives for exploring new CDM opportunities, leading to an improved distribution of CDM projects. If introduced as a mandatory instrument, however, distributional impacts are likely to depend on performance standard stringency. The shift of the baseline development burden from project developers to a dedicated body, as well as standardisation of the baseline, would likely **encourage the participation of underrepresented countries, e.g., least-developed countries (LDCs).** Importantly, the use of fall-back options (e.g., default values for baseline setting) could mobilise further projects in underrepresented regions and project-size categories.

The host country's ability to provide the appropriate data for performance standard calculation is key to institutional feasibility. Furthermore, the capacity to monitor, report and verify emissions and activity data for the relevant sector and its installations needs to be developed in order to make performance standards credible and enable updating at regular intervals. In addition, possible financial support from the surplus of the CDM EB, and multilateral or unilateral support programmes, could be provided to help build institutional capacity.

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Annex I: Standardised approaches in NAP for EU ETS phase II

Below is an overview of the standardised approaches found in the NAPs for the EU ETS phase II (Neelis et al. (2009).

A: Allowance
BAT = Best Available Technique
CCGT = Combined Cycle Gas Turbine
Elec = Electricity
HE = Historical Emissions
HP = Historical Production
IPPC = Integrated Pollution Prevention and Control

Benchmark	AT (Austria)
Valid for	Electricity (existing and new plants) Industry (new plants)
Basic formula used	-
Sectors included	-
Benchmark level	BAT
Data used for bench-mark level	Electricity: 350 t CO_2/GWh, Heat: 175 t CO_2/GWh (with upper and lower caps for the potential factor (i.e. a measure for the ratio allocated to historical emissions)
Basis for activity level	Existing plants: Historical Production
Monitoring mechanism	-
Other remarks	-

Benchmark	BE – W (Belgium Wallonia)
Valid for	Electricity (existing and new plants) Industry (new plants only)
Basic formula used	Electricity: A=HP_{elec}*400
Sectors included	-
Benchmark level	Electricity (all): 400 t CO_2/GWh electricity Industry (new): BAT (BREF)
Data used for bench-mark level	CCGT for the electricity production Industry: non specified
Basis for activity level	Electricity (existing): Historical production All (new): planned capacity and estimate (installed capacity times technology-specific load factor)
Monitoring mechanism	-
Other remarks	BAT as in BREF mentioned as basis for new entrants

Benchmark	BE-F (Belgium Flanders)
Valid for	Industry: existing and new plants Electricity: existing and new plants
Basic formula used	Electricity (existing): A=HPelec*359 Industry (existing): A= HE*factor based on benchmarking
Sectors included	Electricity Industry: all (over a certain threshold)
Benchmark level	Electricity: (new and existing plants): 359 t CO2/GWh electricity Industry: (existing): based on global best practice Industry (new): BAT
Data used for bench-mark level	CCGT for the electricity production Benchmark covenant for the industry based on BAT (worldwide sur-veying).
Basis for activity level	Electricity (existing): standardised load factor for each technology/fuel Industry (existing): Historical emissions All (new): installed capacity times technology-specific load factor
Monitoring mechanism	own benchmarking agency
Other remarks	-

Benchmark	(BG) Bulgaria
Valid for	Electricity (new entrants only) Industry (new entrants only)
Basic formula used	-
Sectors included	-
Benchmark level	Electricity: 350t CO2/GWh Industry: BAT (not specified)
Data used for bench-mark level	Electricity: CCGT
Basis for activity level	All (new entrants): IPPC permit and business plan
Monitoring mechanism	-
Other remarks	-

Benchmark	(CY) Cyprus
Valid for	Electricity (new entrants only) Industry (new entrants only)
Basic formula used	BAT energy consumption * Stated capacity * Fuel factor
Sectors included	-
Benchmark level	-
Data used for bench-mark level	BAT (BREF)
Basis for activity level	All (new entrants): Stated capacity
Monitoring mechanism	-
Other remarks	-

Benchmark	(CZ) Czech Republic
Valid for	Electricity (public utility new entrants only)
Basic formula used	-
Sectors included	-
Benchmark level	CHP generated electricity: 430t CO2/GWh 7t CO2/GWh for district heating
Data used for bench-mark level	REZZO database
Basis for activity level	-
Monitoring mechanism	-
Other remarks	-

Benchmark	(DE) Germany
Valid for	Energy sector (new entrants and existing installations) Industry (new entrants only)
Basic formula used	All (new entrants): A = standardised utilization*stated capacity*BM Electricity (existing): A = average production level in 2002-2005* BM
Sectors included	Electricity / Hot water / Steam Industry specific: Clinker / Recipient glass Flat glass / Clay bricks (2 types) / Roof tiles (2 types) Non-specified industry: BAT
Benchmark level	Electricity: 750 t CO2/GWh coal generated; 350t CO2/GWh natural gas generated Industry: see German NAP2 Annex 3; BAT for non-specified sectors
Data used for bench-mark level	Own figures
Basis for activity level	All (new): 36 Standardised value (see German NAP2 Annex 4) Electricity (existing): historical production
Monitoring mechanism	-
Other remarks	-

Benchmark	(DK) Denmark
Valid for	Electricity sector (new entrants only) Industry sector (new entrants only)
Basic formula used	Direct: CO_2 per capacity installed (e.g. X CO_2e allowances per "tonne capacity per hour")
Sectors included	See Denmark NAP2 Chapter 11.3
Benchmark level	Electricity: 1185tCO2/MWelec +359tCO2/MWheat Industry: own figures based on BAT and adjusted.
Data used for bench-mark level	Unknown
Basis for activity level	All (new): Standard factors
Monitoring mechanism	-
Other remarks	-

Benchmark	(EL) Greece
Valid for	Electricity (new entrants only) Industry (new entrants only)
Basic formula used	-
Sectors included	-
Benchmark level	BAT for energy and based on fuel type
Data used for bench-mark level	BAT (BREF)
Basis for activity level	All (new): Stated Activity level
Monitoring mechanism	-
Other remarks	-

Benchmark	(ES) Spain
Valid for	Electricity sector (existing plants and new entrants) Industry (only new entrants)
Type of benchmark	CO_2
Basic formula used	-
Sectors included	-
Benchmark level	Electricity: BAT (own value) Industry: BAT (BREF)
Data used for bench-mark level	-
Basis for activity level	Electricity (all): standard factor Industry (new): estimate (capacity and average utilization factors in 2005)
Monitoring mechanism	-
Other remarks	-

Benchmark	(FR) France
Valid for	Electricity sector (existing plants and new entrants) Industry: new entrants and large N_2O emitting chemical plants
Basic formula used	-
Sectors included	-
Benchmark level	Coal power generation: 950tCO2/GWh Industry: N_2O emitters: national sectoral average New entrants CO_2 emitters: BAT (with least emitting fuel)
Data used for bench-mark level	Own data for N_2O emitters
Basis for activity level	All (existing and new): forecasted production
Monitoring mechanism	-
Other remarks	-

Benchmark	(HU) Hungary
Valid for	Electricity sector (existing and new plants) Industry (new plants and existing cement plants)
Basic formula used	-

Sectors included	Electricity generation > 50MW Industry: existing cement plants / Lime industry All new entrants
Benchmark level	Electricity (existing): BAT (technology differentiated) Industry (existing): Cement plants: BAT (BREF) Lime sector : Sectoral average All (new): BAT (BREF)
Data used for bench-mark level	BAT based on IPPC for cement plants. Lime industry allocation distributed as share of production (=average BM) based on the phase 1 data.
Basis for activity level	All (existing plants): Historical production All (new): Forecasted production
Monitoring mechanism	-
Other remarks	-

Benchmark	(IE) Ireland
Valid for	Electricity sector (new or recent plants; existing CHP plants) Industry (new or recent cement or lime plants)
Basic formula used	-
Sectors included	3 (Power generation, cement, lime)
Benchmark level	Electricity sector : CCGT for the electricity share of CHP plants Industry: BAT (non-specified)
Data used for bench-mark level	Benchmarks developed by ICF
Basis for activity level	Existing recent plants: historical production Remainder: projected production
Monitoring mechanism	-
Other remarks	-

Benchmark	(IT) Italy
Valid for	Electricity sector (existing and new entrants) Industry (existing and new entrants)
Basic formula used	
Sectors included	Electricity sector (existing and new entrants) Industry: Existing plants: pulp & paper / glass / electric furnaces New entrants: all
Benchmark level	Electricity (existing and new): 350 t CO_2/GWh heat produced by co-generation Industry (existing): Based on own data and with numbers given for 10th and 90th percen-tile (complex calculation). Industry (new): BAT (own)
Data used for bench-mark level	-
Basis for activity level	All (existing): historical production Industry (new): forecasted production
Monitoring mechanism	-
Other remarks	-

Benchmark	(LT) Lithuania
Valid for	Electricity sector (new entrants only) Industry (new entrants only)
Basic formula used	Direct: CO_2 per capacity installed (e.g. X CO_2e allowances per "tonne capacity per hour")
Sectors included	Electricity / heat / glass / ceramic / pilp and paper / mineral oil products / cement and lime / steel and cast iron
Benchmark level	Electricity (new): 2500 allowances per MW capacity. Heat: 600 allow-ances per MW capacity. Industry (new) own figures
Data used for bench-mark level	-
Basis for activity level	-
Monitoring mechanism	-
Other remarks	-

Benchmark	(LU) Luxembourg
Valid for	Electricity sector (new entrants only) Industry (new entrants only)
Basic formula used	A=Utilization*Activity level*BM
Sectors included	Electricity / hot water / process steam / cement clinker / flat glass / container glass / clay bricks / roof tiles
Benchmark level	Electricity: 365 t CO_2/GWh Industry: conform NAP2 Table 8
Data used for bench-mark level	Study
Basis for activity level	All (new): Standardised factors
Monitoring mechanism	-
Other remarks	-

Benchmark	(LV) Latvia
Valid for	Electricity sector (new entrants only) Industry (new entrants only)
Basic formula used	
Sectors included	Electricity sector (new entrants only) Industry (new entrants only)
Number of bench-marks	
Benchmark level	Electricity (new): 80% fuel utilization factor for coal based cogeneration. 40% efficiency for coal based generation. 85% fuel utilization factor for natural gas based cogeneration. 50% efficiency for natural gas based generation
Data used for bench-mark level	Based on the methodology and figures from 2004/156/EC
Basis for activity level	All (new): Estimate based on the technical capacity and the market
Monitoring mechanism	
Other remarks	

Benchmark	(MT) Malta
Valid for	Electricity sector (new entrants only) Industry (new entrants only)
Basic formula used	-
Sectors included	-
Benchmark level	BAT for the type of fuel/generation
Data used for bench-mark level	BAT (BREF)
Basis for activity level	-
Monitoring mechanism	-
Other remarks	-

Benchmark	(NL) The Netherlands
Valid for	Electricity sector (existing and new entrants) Industry sector (new entrants and existing plants taking part in the BM covenant)
Basic formula used	Existing plants: A=Historical emissions*Relative energy efficiency
Sectors included	Power generation CO_2 Industrial sectors CO_2 (all) Nitric acid production N2O
Benchmark level	Electricity(all): Fuel specific Nitric acid (all): 1.8kg N2O/t. Industry (new): BAT Industry (existing) : index based on the relative energy efficiency
Data used for bench-mark level	Distance to the BAT on a worldwide basis
Basis for activity level	All (existing): Historic production level*growth rate All (new): standardised factors
Monitoring mechanism	Dutch Benchmarking Verification Agency
Other remarks	The Netherlands benchmarks a very large number of processes and is the only country in the EU to have accumulated such a long experience in benchmarking.

Benchmark	(PL) Poland
Valid for	Electricity sector (new entrants and existing plants) Industry (new entrants and existing plants)
Type of benchmark	Electricity sector: SOx emissions based Industry: CO_2
Basic formula used	-
Sectors included	Electricity and CHP Industrial sectors: Refining / Coking / Iron & Steel Cement / Lime / Paper / Glass / Ceramic / Chemical Sugar
Benchmark level	Industry (all): New plants: KASHUE (own procedure) Existing plants: calculated based on national data and negotiated on a sectoral basis.
Data used for bench-mark level	Industry: own data
Basis for activity level	Industry (existing): Historical production & production forecast Industry (new): permit & production forecast
Monitoring mechanism	-
Other remarks	-

Benchmark	(RO) Romania
Valid for	Electricity sector (new entrants only) Industry sector (new entrants only)
Basic formula used	-
Sectors included	-
Benchmark level	BAT (non-specified)
Data used for bench-mark level	-
Basis for activity level	All (new): production forecast
Monitoring mechanism	-
Other remarks	-

Benchmark	(SI) Slovenia
Valid for	Electricity sector (new entrants and existing plants) Industry (only new plants)
Basic formula used	-
Sectors included	-
Benchmark level	Electricity (existing): Fuel specific benchmark. Electricity (new): 0.2tCO_2/MWh heat; 0.35tCO_2/MWh electricity Industry (new): BAT (BREF).
Data used for bench-mark level	-
Basis for activity level	All (existing): Historical production
Monitoring mechanism	-
Other remarks	-

Benchmark	(SK) Slovakia
Valid for	Electricity (existing plants) Industry (existing cement plants)
Basic formula used	Historic average – no further information
Sectors included	-
Benchmark level	Cement: 0.64 tCO_2e/t grey cement (1.1 for white cements)
Data used for bench-mark level	All (existing): Historical emissions and production levels.
Basis for activity level	-
Monitoring mechanism	-
Other remarks	-

Benchmark	(SE) Sweden
Valid for	Electricity sector (recent and new plants) Industry (only primary steel – existing installations)
Basic formula used	-
Sectors included	-
Benchmark level	Electricity (new) 337tCO2/GWh electricity and 118tCO2/GWh heat Steel (existing): 1.91 t CO2 / t steel ingot
Data used for bench-mark level	Electricity: Own BAT Steel: EU wide average
Basis for activity level	All (existing): historical production Industry (existing): production forecast
Monitoring mechanism	-
Other remarks	-

Benchmark	(UK) United Kingdom
Valid for	Large electricity producers (new and existing) Industry (new entrants)
Basic formula used	Complete calculation spreadsheets available in a transparent manner. (See Annexes to UK NAP2)
Sectors included	-
Benchmark level	All: Own calculated levels, close to BAT.
Data used for bench-mark level	Benchmarks established through several studies.
Basis for activity level	Electricity (existing): historical levels All (new): standardised factor
Monitoring mechanism	-
Other remarks	The UK is the only country having provided a large transparent and detailed benchmarking effort.

Annex II: Standardised approaches in existing CDM methodologies

	Aggregation	Data	Stringency	Updating
Tool to calculate the emission factor for an electricity system	(1) Process: Not differentiated (2) Product: Power production (MWh) (3) Time: • OM[95]: Not differentiated • BM[96]: 5 most recently built plants, or a set of recently built plants that comprise 20% of the total power production in the grid (4) Space: Grid system	Empirical: • OM: Recent 3 years • BM: The most recent year	Average	• Ex-ante determination, plus updating at CP renewal, or • Annual updating
AM0030	(1) Process: Differentiated by smelter technology type (2) Product: Primary aluminium production (t Al) (3) Time: Not differentiated (4) Space: Global[97]	Empirical (IAI benchmarking survey result of the most recent year)	Average[98]	Updating at CP renewal

[95] OM: Operating Margin, the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed CDM project activity
[96] BM: Build Margin, the emission factor that refers to the group of prospective power plants whose construction and future operation would be affected by the proposed CDM project activity.
[97] More precisely, the special boundary is defined by the location of IAI members participated in their Anode Effect Survey.
[98] The benchmarking is used only as a safety valve to set a reference level of baseline emissions to compare the actual emission level.

	Aggregation	Data	Stringency	Updating
AM0037	(1) Process: Not differentiated (2) Product: Useful chemical production (t useful product) (3) Time: Plants built in the recent 5 years (4) Space: • Default: Host country if the product is traded regionally, or all countries if globally traded • If the sample is smaller than 5 plants, expand the boundary to all neighbouring countries (both non-Annex I and Annex I)	• Empirical (the most recent year), or • Conservative default value (IPCC)	Average of top 20% performers	Updating at CP renewal
AM0059	(1) Process: Differentiated by smelting technology type (2) Product: Primary aluminium production (t Al) (3) Time: Not differentiated (4) Space: Global[99]	Empirical (IAI survey result of the most recent year)	• PFC emissions: Average of top 20% performers • Power consumption: Average[100]	Updating at CP renewal

[99] More precisely, the special boundary is defined by the location of IAI members participated in their Anode Effect Survey.
[100] The benchmarking is used only as a safety valve to set a reference level of baseline emissions to compare the actual emission level.

	Aggregation	Data	Stringency	Updating
AM0063	(1) Process: Not differentiated (2) Product: CO_2 produced (t CO_2) (3) Time: Plants built in the recent 10 years (4) Space: • Default: Host country • If the sample size is smaller than 5 plants, expand the boundary to all neighbouring countries (both non-Annex I and Annex I)	• Empirical (the most recent year), or • Manufacture's specifications, or • Conservative default value (0 t CO_2e/t CO_2)	Average of top 20% performers	Updating at CP renewal
AM0067	(1) Process: Differentiated by the type of transformer: capacity (kVA) and transmission ratio. (2) Product: No-load loss rate (W)[101] (3) Time: Transformers installed in the recent 5 years (4) Space: The concession area which contains the project activity area[102]	Manufacturer's specifications	Average of top 20% performers	Updating at CP renewal

[101] No-load losses or core losses are losses due to transformer core magnetizing or energizing. These losses occur whenever a transformer is energized and remain constant regardless of the amount of electricity flowing through it.
[102] Concession area is the territory where an specific utility has the authorization to operate.

	Aggregation	Data	Stringency	Updating
AM0070	(1) Process: Differentiated by storage volume class, and refrigerator design (2) Product: Refrigerated storage volume (litre) (3) Time: Newly manufactured and sold refrigerators in the most recent year (4) Space: Households to which the efficient refrigerators were sold	Empirical (Recent 3 years[103])	Average of top 20% performers	• Ex-ante determination with adjustment for technology improvement [104], plus updating at CP renewal, or • Annual updating
ACM0005	(1) Process: Not differentiated (2) Product: Mass percentage of clinkers (t clinker/ t blended cement) (3) Time: Not differentiated (4) Space: • Default: Host country • Sub-region can be used upon satisfaction of certain conditions	Empirical (The most recent year)	• Average of the 5 highest blend cement brands, or • Average of top 20% performers	Ex-ante determination with adjustment for cement blending trend in the market105

[103] More precisely, the market benchmarking option requires data for max. 3 years, while the manufacturer benchmarking option requires 3-year data.
[104] The technology improvement rate is either determined based on the empirical 10-year data, or a default value of 3.5%.
[105] A default value of 2%/yr is used.

	Aggregation	Data	Stringency	Updating
ACM0013	(1) Process: The same fuel, the same load category, and similar plant capacity (± 50% range) (2) Product: Power production (MWh) (3) Time: Plants built in the recent 5 years (4) Space: • Default: Host country • If the sample size is smaller than 10 plants, expand the boundary to all neighbouring non-Annex I countries. If the minimum size is not met, the boundary shall be further expanded to all non-Annex I countries in the continent.	Empirical (The most recent year)	Average of top 15% performers	Updating at CP renewal
ACM0015	(1) Process: Not differentiated (2) Product: Non-carbonate content (t CaO or MgO/t raw material) (3) Time: Not differentiated (4) Space: 200-km radius from the project activity plant[106]	Empirical (Lab analysis by an independent authorized entity)	• Average of the 20% performer plants, or • Average of top 5 performers[107]	Updating at CP renewal

[106] The methodology requires the spatial boundary to encompass at least the 10 plants nearest to the project activity plant.
[107] Top 20% in cumulative clinker production, while top 5 in number of clinker production plants.