Solving the MRV challenge for new market-based mechanisms:

What can past experience teach us?

Discussion Paper

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Summary

The new market-based mechanisms (NMBM) being discussed in the climate change negotiations will require a monitoring, reporting and verification (MRV) system that enables a transparent accounting of their contribution to greenhouse gas (GHG) emission reductions. This discussion paper analyses how such a MRV system for the new market-based mechanisms can be designed so that it complies with the criteria of environmental integrity, data availability, transparency, cost-efficiency, a sound institutional framework and transferability. To do so, in a first step, the general academic and political discussion on MRV is summarized; then, lessons are drawn from existing MRV systems; finally, proposals are put forward for the MRV of new sectoral market-based mechanisms.

For designing a MRV system for NMBM, the CDM can provide a good starting point with its established methodologies, rules and institutions. However, its framework has to be adapted when moving from the project to the sectoral level, because for example the role of national MRV institutions will be more important. Second, the European Union's Emissions Trading System (EU ETS) provides important lessons for the setup of institutions and MRV of data at the sectoral level (flexibility needed, tiered approach of data accuracy, etc.). Third, new data collection, reporting and verification systems for developing countries are being currently negotiated, including systems for internationally supported and non-supported NAMAs, and for biennial updates of national emission inventories. While all these systems are not yet implemented, the MRV of NMBM should be consistent with these systems to avoid double counting and overlaps.

From the analysis of the EU ETS and CDM methodologies covering sectors (buildings, cement and power), we derive the following institutional and data requirements for a credible MRV system of new market-based mechanisms.

Regarding institutions, various national and international institutions will need to be created. Particularly the national ones will be important, very similar to the EU ETS, as data from whole sectors has to be monitored and reported. We assume that at least a national coordination entity and national regulations are required.

At the international level, we propose to establish an institutional architecture that is very similar to the one of the CDM: a governing body taking politically sensitive decisions, several technical groups as well as an administrative support unit assisting the governing body, and internationally accredited verifiers, who are responsible for time consuming tasks and easily verifiable data. However, the concrete role of bodies will very much depend on the post-2012 architecture of the climate regime.

The most important conclusion is that MRV of NMBM will very much depend on the outcome of the climate negotiations, mainly whether NMBM are governed internationally coordinated or not. An internationally coordinated MRV system would more easily ensure environmental integrity because of common rules and accounting. However, a rather uncoordinated system is not unlikely given the current negotiations. Therefore, more analysis has to be done on institutions and MRV guidelines required to ensure a minimum of environmental integrity of NMBM in the case of an internationally uncoordinated regime.

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1 Introduction

The new market-based mechanisms (NMBM) being discussed in the climate change negotiations will require a monitoring, reporting and verification (MRV) system that enables a transparent accounting of their contribution to greenhouse gas (GHG) emission reductions. Two existing strands of MRV can provide lessons for designing this new system: MRV of project-based market mechanisms such as the Clean Development Mechanism (CDM) under the Kyoto Protocol and MRV of national climate change mitigation actions and greenhouse gas inventories.

For project-based market mechanisms, such as the CDM, MRV is an essential element to ensure environmental integrity. While the wording of “MRV” is not explicitly used, all CDM projects are required to monitor greenhouse gas emission reductions, to compile monitoring reports and to submit these reports to external verification. However, MRV under the CDM cannot be simply transferred to those NMBM that will address national or sectoral actions,[1] rather than project-based interventions as in the CDM. Therefore, the existing MRV of national mitigation actions and targets of industrialised countries – which are sometimes structured along specific sectors and industries – is a valuable experience that can inform the design of MRV for NMBM.

For national mitigation actions, MRV elements have already been included under both the United Nations Framework on Climate Change (UNFCCC) in 1992 and the Kyoto Protocol in 1997.[2] However, the wording of MRV was only introduced under the Bali Action Plan in 2007, when countries agreed to undertake measurable, reportable and verifiable (MRV) Nationally Appropriate Mitigation Actions (NAMAs), in the case of developing countries “supported and enabled by technology, financing and capacity building” (UNFCCC 2007). The emergence of new market-based mechanism proposals in subsequent COP negotiations represents a challenge to policy makers on how best to design MRV systems that ensure environmental integrity, consistency with the existing system, avoid overlap between MRV of NAMAs and of new market-based mechanisms, and are accepted by the international community.

This discussion paper analyses how a MRV system for the new market-based mechanisms can be designed so that it complies with the criteria of environmental integrity, data availability, transparency, cost-efficiency, a sound institutional framework and transferability. To do so, in a first step, the general academic and political discussion on MRV is summarized; then, lessons are drawn from existing MRV systems in the CDM, the EU ETS and a voluntary sectoral reporting initiative; and finally, proposals are put forward for the MRV of new sectoral market-based mechanisms.

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1 While the negotiations regarding new market-based mechanisms are still open regarding the form that these new mechanisms will take, in this study we focus mostly on sectoral market mechanisms, particularly sectoral crediting and sectoral trading.

2 The reporting requirement under the Kyoto Protocol are very different: while developing countries are only requested to report on programmes containing mitigation measures in their national communications (normally, every 5-15 years), industrialized countries have to submit more regular and detailed national communications, and every year an inventory of greenhouse gas emissions (UNFCCC 2007).

2 Overview of the academic and political discussion

In the following we provide an overview of the academic and political discussion on specific MRV requirements for sectoral mechanisms. We will firstly outline the objective of MRV before providing a more detailed description of the three components and desirable characteristics of MRV systems that may be suitable for sectoral mechanisms.

According to Breidenich & Bodansky (2009), the role of MRV in any new agreement for a post-2012 climate regime is multifaceted. The three components of an MRV system may facilitate progress towards a new climate agreement by:

- Measuring the progress of countries towards the objective of an agreement, this may encourage international collaboration on the establishment of baselines and the identification of mitigation potentials;
- Reporting the mitigation actions of a country to recognise their effort at an international level, which will allow for independent review of these mitigation actions with the possibility of learning from them and improving policy measures where necessary;
- Verifying the outcome of the mitigation actions that are reported and measured by a country ensuring that there is *mutual confidence* in the action of countries' and in the climate regime itself.

In essence, the fundamental objective of an MRV system is to provide credibility to a new agreement on the post-2012 climate regime; and such credibility is vitally important in order to maintain the mutual confidence of participating countries in the process. Given that the nature of any obligations (commitments, support, actions, etc.) and MRV systems is not explicitly defined in the Bali Action Plan, both are subject to ongoing negotiations at the COP level (Fransen 2009).

Within these negotiations, the role of new market-based mechanisms and the conditions necessary to enable emission reductions to be measured, reported and verified are being carefully considered. To a certain extent, the terms *measurable*, *reportable* and *verifiable* are all closely linked, however it is important to acknowledge that each component of MRV presents a distinct set of issues concerning the design of MRV systems for new market-based mechanisms.

Breidenich & Bodansky (2009, p. 3) define the function of **measurement** as a means "to describe a phenomenon in reasonably precise, objective terms – that is, in terms of an established standard or unit of measurement." The unit of measurement can refer to both direct physical measurement as well as an estimation based on indicators, which can be quantitative or even qualitative. For example, national emission inventories are often based upon an estimation of GHG emissions that are derived from the product of activity data and GHG emission factors. Although measurement is normally associated with quantification, "it can also be based on qualitative metrics, provided that they can be evaluated in an objective manner" (Fransen 2009, p. 2).

Reporting involves the provision of information by all countries that have approved the terms of an international agreement. Breidenich & Bodansky (2009) suggest that the provision of information may include national conditions (GDP, climate, etc.), government policies and measures (tax policies, subsidies, etc.), environmental results (emission levels, etc.) and private activities (activity levels, technology investments, etc.). Successful reporting depends upon "the precision and reliability of the reported information" by actors (i.e. states, business actors, non-governmental actors, independent experts and international institutions) and "the degree to which information is presented in a transparent and standardised way that allows comparison between reports and verification by others" (Breidenich & Bodansky 2009, p. 5).

Verification refers to "the process of independently checking the accuracy and reliability of reported information or the procedures used to generate information" (Breidenich & Bodansky 2009, p. 6). Verification is considered a technical non-judgemental function, which involves the factual accuracy of information. It is therefore a distinct term, which is not necessarily either political (i.e. a review) or legal (i.e. compliance) in nature (Breidenich & Bodansky 2009). The verification of the mitigation action of a country is dependent upon the extent to which data is capable of being verified (i.e. quantitative and qualitative data), the actors involved (other states, accredited private entities, NGOs, etc.) and the way in which the verification process is implemented (onsite inspections, onsite monitoring, remote monitoring, etc.). The way in which sectoral mitigation actions of countries can be monitored, reported and verified depends upon the sectoral approach implemented.

The introduction of sectoral crediting (i.e. the issuance of credits for the difference between actual emissions in a sector and the crediting threshold) or sectoral trading (i.e. the definition of a sectoral cap and the issuance of tradable emission permits up to that cap) would require reliable, transparent and standardised data on sectoral emission reductions. The determination of emission reductions would require a measurement of actual emissions and the establishment of quantified baseline projections (Ellis & Moarif 2009), which would be particularly challenging to determine "since the future development of GHG emissions are driven by many factors, such as economic growth, population growth, international fuel prices, technological innovation" (Schneider & Cames 2009). Indeed, the identification of a baseline projection may be complicated further if it refers to a sub-sector as the interaction of separate mitigation actions by a country within the same sector may impact baseline calculations (Jung et al. 2010). In addition, the reporting and verification of information would be more difficult to implement if activities are defined at the sub-sector level and differ from the sectoral disaggregation used in official statistics (Ellis & Moarif 2009).

It is evident that the existing monitoring and reporting requirements under the Kyoto Protocol will have to be further developed to enable emission reductions from new market-based mechanisms to be *measured, reported and verified*. According to Fransen (2009), even the national communications and inventories for Annex I Parties are currently not adequate to contribute to MRV under a post-2012 agreement. Given the less stringent requirements for non-Annex I Parties, they would even be less appropriate as a basis for future MRV. This may be particularly true for the MRV requirements of new market-based mechanisms because the required sectoral information may currently not (or not accurately) be reported in national communications. However, attempts should be made to build upon the existing monitoring and reporting procedures that have widespread support amongst the Parties to the Kyoto Protocol.

It is suggested that the post-2012 framework needs to extend monitoring requirements to developing countries. Given that new market-based mechanisms are designed to realise mitigation potentials in certain sectors of developing countries, it is essential that the inventories of the developing countries with significant emissions become more frequent and complete.

Many countries have advanced the concept of a registry to recognise the mitigation efforts of developing countries in the international framework and to prioritise the distribution of financial and technology support from developed countries. While the idea of a registry has widespread support in principle, the way it would operate is still subject to ongoing negotiation with the MRV requirements potentially varying depending upon the type of NAMA (unilateral, supported or market-based), the market mechanism used (crediting or trading) and the national circumstances of the developing country (McMahon et al. 2009). However, if the outcome of the negotiations in terms of MRV stringency is weak, the credibility of the underlying agreement would be reduced.

In conclusion, the fundamental purpose of MRV is to communicate progress and provide credibility for the mitigation actions of a country in a manner that is internationally comparable with the efforts of other parties to an environmental agreement. The emergence of new market-based mechanisms in a post-2012 agreement presents various challenges to how information is currently measured, reported and verified. From a technical perspective, it is evident that the measurement of data at a sectoral or even sub-sectoral level will require additional skills and capacities to define sectoral boundaries and baselines. Furthermore, reporting and verification processes will require data to be more disaggregated and standardised amongst all of the participating countries. From a political perspective, there needs to be an international agreement on a MRV system that would extend beyond the Kyoto Protocol Parties to include MRV procedures for non-Annex I countries. These technical and political challenges will need to be addressed to ensure *mutual confidence* amongst the Parties in order to provide the necessary conditions for new market-based mechanisms in a post-2012 regime to succeed.

3 Description of criteria for analysing existing MRV systems and designing new ones

The main purpose of MRV systems is to safeguard environmental integrity. Therefore MRV systems need to comply, inter alia, with following principles (EU 2004, p. 4-5):

- **Completeness**: All greenhouse gas emissions from all sources covered by the respective scheme need to be monitored and reported.
- **Accuracy**: emission determination should be systematically resulting in data neither under nor over actual emissions; uncertainties should be reduced as far as practicable and quantified to the extent possible; metering and testing equipment used to monitor emissions should be calibrated and regularly maintained; data processing tools used in determining emissions should be free from errors.
- **Conservativeness**: in the interest of environmental integrity, wherever uncertainties in determining emission levels are remaining, it is better to err on the lower bound (underestimating the emission reductions).
- **Materiality**: Only information whose omission or misstatement could influence the decision of users should be taken into account; in that sense, materiality provides a cut-off threshold for the size potential of omissions or misstatements.
- **Consistency**: Emission data should be comparable over time by using the same monitoring methodologies; monitoring methodologies should only be changed if the new methodology ensures improved completeness or accuracy.

- **Cost effectiveness**: the accuracy of monitoring methodologies should be balanced against the additional cost; those methodologies should be applied which provide the highest accuracy unless their application is technically unfeasible or would lead to unreasonable high cost.
- **Adjustability**: monitoring methodologies should be improved if more accurate data or methodologies become available.
- **Transparency**: all data required to determine emissions, including activity data, emission factors, assumptions, references, etc., should be analysed and recorded in such way that it can be reproduced by surveillance entities.

Some of these criteria are conflicting so that a balance between them needs to be identified (e.g. consistency versus improvement). How that balance would look like cannot be determined in general but depends on the detailed circumstances of the respective subject that needs to be monitored, reported and verified.

Based on these principles we derive the following criteria for the assessment of existing sectoral MRV systems:

Criterion	Key questions
Environmental integrity	Does the MRV system safeguard environmental integrity by ensuring high levels of completeness, accuracy and consistency? Is conservativeness guaranteed?
Data availability	Are all the data required to determine baseline and actual emissions available, including activity data, emissions or conversion factors, etc.? To which extent data needs to be gathered before the start of the system and which data may be considered sensitive since it would be considered as confidential business data?
Transparency	Are the emission data gathered made publically available for any interested person or body? Are additional data made publically available and if yes, which additional data?
Cost-efficiency	Does the MRV system result in unreasonably high cost? How could the costs of MRV be reduced without undermining environmental integrity?
Institutional feasibility	Which bodies need to be established to apply the MRV system and to which extent already existing bodies can be mandated with the required tasks?
Transferability	In which context is the MRV system applied so far? Can it be transferred to developing countries and which criteria in terms of size, governance, institutional framework, etc. those countries need to comply with?

The existing MRV systems will be analysed in a qualitative manner on the basis of these criteria, taking into account the actual circumstances of the context where the system is applied up to now.

4 Analysis of existing MRV systems

4.1 European Union Emissions Trading Scheme

The monitoring and reporting of greenhouse gas emissions in the EU Emissions Trading Scheme (ETS) is based upon the guidance provided by the Commission Decision 2004/156/EC. The coverage of the EU ETS includes any combustion installation with a rated thermal input exceeding 20 MW and the operators of these installations are required to adhere to the monitoring and reporting guidelines expressed by the Commission in order to use emission permits (Directive 2003/87/EC).

A *monitoring methodology* needs to be submitted by the operator of an installation to the *competent authority*, which describes the activities carried out by an installation to be monitored and the methodology used "for the determination of emissions, including the choice between calculation and measurement and the choice of tiers" (Decision 2004/156/EC).

The monitoring and reporting guidelines provided in the Commission Decision 2004/156/EC establish a tier system for the calculation of greenhouse gas emissions defining a hierarchy of different accuracy levels for activity data, emission factors and oxidation or conversion factors. In principle the operator is obligated to apply the highest tier level (i.e. the highest level of accuracy) unless this is technically or economically not feasible.

The use of a measurement based methodology (i.e. metering devices) to monitor the greenhouse gas emissions of an installation can only be implemented if the output is more accurate than the calculation based methodology. The accuracy of measurement is determined based on the level of uncertainty associated with metering equipment, calibration and "any additional uncertainty connected to how the metering equipment is used in practice" (Decision 2004/156/EC).

The operator of the installation is required to report the monitoring of greenhouse gas emissions in accordance with the reporting format outlined in the Decision 2004/156/EC and to ensure that all monitoring methodologies are subject to independent verification.

4.1.1 Environmental Integrity

Completeness: "The monitoring and reporting process for an installation shall include all emissions from all sources belonging to activities listed in Annex to the Directive 2003/87/EC" (Decision 2004/156/EC). Despite this objective of being complete, two aspects need to be discussed here. Only installations above 20 MW of thermal input are part of the EU ETS system. While reducing costs of monitoring, this approach may lead to leakage to smaller installations. An additional aspect is how emissions from electricity are accounted for. Under the EU ETS, electricity emissions are accounted through the allocation of allowances to power generation companies, which are supposed to pass the higher cost of GHG emitting electricity to their consumers. In order not to price electricity emissions doubly, they are thus not included in the accounting for industrial installations. While this approach is appropriate for the EU ETS due to its broad coverage, it may not be appropriate for sectoral market mechanisms in developing countries, as in this case there is no certainty that emissions from electricity use or consumption are accounted for. If they are not, and the benchmark or baseline for the sector only considers direct emissions (e.g. from fuel combustion during the production process), this could create the perverse incentive to increase the use of electricity in order to substitute fuel combustion.

Accuracy: The accuracy of the monitoring and reporting is ensured within the MRV system by obligating the operators of installations to conform to the highest level of accuracy as defined by the *tier approach* (unless this is not technically or financially feasible) when using either the calculation or measurement based methodology. However, the European Environment Agency (EEA 2006) reports difficulties in the implementation of this tiered approach: during the ETS Phase I, in some countries the minimum tiers were not yet technically feasible by 2005. In about 20% of the installations above 500 kt annual emissions, either the activity data, the emission factor or the net calorific value could not be calculated according to the minimum tier requirements for at least one fuel. This shows that, even if the regulations try to ensure data quality, during implementation the strict requirements had to be adapted to the reality of the sectors, at least during an initial learning period.

Conservativeness: To determine how many emission allowances should be allocated to new installations, a benchmark approach was introduced, and each member country established its own benchmark. Hermann (2010) discusses that the benchmarks in the cement sector were set in most countries on the basis of the best available technology (BAT), which should ensure accuracy in determining desirable emission levels. However, a case study of the German cement benchmark shows that even when utilising BAT as the basis for the benchmark, this one was not stringent enough, because it did not take into account the high share in use of waste fuels for the clinkering process, because the load factor chosen was too high, and because there were different benchmarks for different technologies, failing to set an incentive to make broader technological improvements.

Consistency: The emission data monitored is comparable over time, with the monitoring methodology only changed if the accuracy of the reported data is improved (Decision 2004/156/EC).

4.1.2 Data Availability

Data available: In the context of the power sector, the calculation of greenhouse gas emissions from combustion is the product of fuel consumption, an emission factor and an oxidation factor (Decision 2004/156/EC) with the accuracy (i.e. certainty) of the data dependent upon the tier approach. For example, according to the Commission Decision 2004/156/EC the use of an emission factor of a fuel may be determined by using either "reference factors for each fuel as specified in section 8 of Annex I" (i.e. Tier 1) or alternatively by referring to country specific emission factors for the fuel type as 'reported by the respective Member State in its latest national inventory submitted' to the UNFCCC (i.e. Tier 2a).

The flexibility provided by this tier approach in the MRV guidelines (Decision 2004/156/EC) ensures that data in most circumstances are available for installations to calculate their greenhouse gas emissions whilst also documenting a transparent way to improve the quality of monitoring over time.

Data to be collected: If the measurement based approach is implemented by an operator of an installation to monitor greenhouse gas emissions, the measurement data will need to be frequently collected along with information on the uncertainty associated with the measurement. Otherwise, data on fuel consumption is used for the calculation based methodology.

4.1.3 Transparency

Public availability of emission data: In the EU ETS, the greenhouse gas emission data are made publically available on an annual basis to ensure complete transparency. The operators of the installations covered in the scheme are required to report emission data according to the format set out in the Commission Decision 2004/156/EC.

Public availability of additional data: Information is also provided on the number of permits submitted, purchased/sold or banked at the end of the year for each installation.

4.1.4 Cost-efficiency

Cost of MRV system: The tier approach outlined in the MRV guidelines provides a balance between the accuracy of monitoring and the additional cost of the methodology.

Reduction of MRV costs: Provisions are included within the Commission Decision 2004/156/EC to ensure that if the monitoring and reporting of information at a certain level of accuracy leads to *unreasonably high costs* for the operator of an installation, then information can be monitored and reported according to a lower tier of accuracy. However, the competent authority must be satisfied that this is the case before allowing an installation to collect information at a lower level of accuracy.

4.1.5 Institutional Framework

Responsible authorities: The monitoring and reporting of greenhouse gas emissions in the EU ETS system required the establishment of registries to account for the greenhouse gas emissions of the participating installations. National authorities have been responsible for setting up registries to facilitate emissions trading. In addition to the registration of verified emissions, this involves accounting for the surrender of permits at the end of the year by installations along with additional information on the selling or purchase and banking of permits. According to EEA (2006), in most participating countries, more than one authority is involved in the national implementation of the EU ETS, and sometimes emissions monitoring and issuance of permits is carried out by local or regional authorities. To avoid inconsistencies in implementation at the national level, working groups with regular meetings, specific guidance notes and/or training courses for the authorities have been carried out.

In addition, a network of independent accredited verification bodies has been established to ensure that the monitoring and reporting of emissions by the operators of the participating installations were implemented in accordance with the MRV guidelines.

4.1.6 Transferability

Applicability of MRV system in developing countries: Based upon the lessons learnt from the EU ETS, a similar scheme for developing countries may be feasible if technical support is provided. The implementation of NAMAs may act as a first step (akin to the EU ETS phase I) towards improved MRV of greenhouse gas emissions to implement a similar scheme in the future. One possible implementation would be to establish market-based pilot schemes in developing countries, which already receive emission units (credits or allowances) that are fully fungible with the international system. However, to ensure environmental integrity during this pilot, either the issuing body would issue less credits than those verified or the buying party would cancel part of the credits received.[3]

4.2 Power under the CDM

There are a number of CDM baseline and monitoring methodologies for projects in the power sector. As an example we analyse the consolidated baseline and monitoring methodology ACM0002.[4] This methodology is applicable to CDM projects that either install, increase capacity, retrofit or replace grid-connected electricity generation from renewable sources (hydro, wind, geothermal, solar, wave or tidal power).

Depending upon the CDM project type covered by this methodology, the identification of a baseline scenario will be slightly different. For example, the installation of a new grid-connected renewable power plant/unit assumes that the electricity delivered to the grid by the project activity would have otherwise been generated by the existing electricity grid, which is associated with a specific emission factor. Alternatively a capacity addition to an existing grid connected renewable power plant/unit assumes in the baseline scenario that in the absence of the CDM project activity the existing facility would continue to supply electricity to the grid at historical levels.

The identification of such baseline scenarios for CDM projects and the subsequent demonstration of additionality through tests such as the barrier analysis and investment analysis are essential elements of the CDM project cycle.

The issuance of CERs will depend upon the emission reductions that are estimated to occur from the displacement of electricity generation from fossil fuel power plants during the proposed crediting period of the CDM project activity (i.e. installation, capacity addition, retrofit and replacement). Independent verification by Designated Operational Entities (DOEs) is required to ensure that all Certified Emission Reductions (CERs) issued for emission reductions to CDM project developers are real.

4.2.1 Environmental Integrity

Completeness: All of the main greenhouse gas emission sources for the baseline scenario (i.e. CO_2) and the project activity (i.e. CO_2, CH_4) are accounted for in methodology ACM0002.

Accuracy: As an offsetting mechanism, the CDM projects currently depend upon the concept of additionality to ensure their environmental integrity. A project is regarded as additional if it would not have been implemented without the incentive from the CDM. This is demonstrated in methodology ACM0002 through a barrier analysis and (in most cases) an investment analysis. However the current approach has been criticised as being very subjective and difficult to validate in an objective manner.

The ability to accurately measure the GHG reductions that result from CDM projects covered by the methodology is also an essential requirement for maintaining environmental integrity. In

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[3] It is not advisable to introduce different kinds of tradable units here (as in the case of afforestation/reforestation projects in the CDM), because this would lead to fragmentation of the market.

[4] http://cdm.unfccc.int/methodologies/DB/C505BVV9P8VSNNV3LTK1BP3OR24Y5L

order to achieve this accuracy within methodology ACM0002, the quantity of net electricity generation annually supplied to the grid by the plant or unit that has been added under the project activity is required to be measured using electricity meters. The use of such a measurement device, which is used according to relevant industry standards, ensures a high level of accuracy on the amount of electricity generated. While this data on produced electricity is very accurate, the overall estimation of emission reductions in ACM0002 relies on less accurate data on emissions produced by existing power plants (Michaelowa 2011) and at least three challengeable assumptions: First, the methodology assumes that mainly power from coal, oil and gas power plants are replaced but no generation from renewable energy and nuclear (exception: largely hydro-based grids). Second, the methodology assumes 100% replacement of other electricity as consequence of renewable electricity production. Third, ACM0002 assumes that the replaced emissions can be accurately estimated by taking specific weights for emissions from all power plants on the grid and for emissions of the recently built power stations. Therefore, the calculated emission reductions represent a "best estimate under specific assumptions" rather than an exact value (which can never be attained).

The monitoring of emissions associated with the production of electricity from geothermal and solar thermal projects requires a calculation of the annual fuel consumption based upon emission factors approved by the CDM Executive Board.

Consistency: The requirement for the continuous measurement of the net electricity generation annually supplied to the grid by the plant or unit that has been added under the project activity should ensure that the data will be comparable over time. The CDM Executive Board will only approve changes to methodology ACM0002 if the accuracy or completeness of the data can be improved.

4.2.2 Data Availability

Data available: Methodology ACM0002 refers to the use of several tools approved by the CDM Executive Board to calculate the emission factor for an electricity system, to demonstrate and assess project additionality, to identify the baseline scenario and to calculate project emissions from fossil fuel combustion.

Data to be collected: The quantity of net electricity generation supplied by the project plant/unit to the grid needs to be measured, and data on the GHG-intensity of the grid (if not already published by national institutions) needs to be collected for CDM projects covered by methodology ACM0002.

4.2.3 Transparency

Public availability of emission data: The UNFCCC publishes information on the CERs issued to all of the CDM projects that have successfully completed the MRV requirements associated with the CDM project cycle.

Public availability of additional data: Information on the status of a CDM project (i.e. registered, rejected, under review) is also available from the UNFCCC, as well as the Project Design Document (PDD) detailing the project's baseline and monitoring methodology and its projected emission reductions.

4.2.4 Cost-efficiency

Cost of MRV system: Transaction costs (i.e. project identification, methodology development, project documentation) are an important factor influencing the cost-effectiveness of the CDM. The cost of monitoring, reporting and verifying the emission reductions from CDM projects results in considerable costs and risks to the CDM project developer and particularly undermine the incentive for developing small-scale renewable projects.

4.2.5 Institutional Framework

Responsible authorities: The CDM Executive Board supervises the CDM and is responsible for the registration of CDM projects and the issuance of CERs. A Methodologies Panel was established to support the CDM Executive Board by providing recommendations on methodologies for baselines and monitoring plans. Designated Operational Entities (DOEs) are responsible for independently validating the PDDs and verifying the emission reductions reported by a project owner. In addition, a Designated National Authority (DNA) is required to approve the development of a CDM project proposed by a CDM project developer.

The CDM institutional framework has been criticised due to its low effectiveness in dealing with the large flow of projects (both at the DOE and the CDM Executive Board level), and to misaligned incentives for DOEs, which by being hired by the project proponents have an incentive to satisfy the client and facilitate registration, rather than to ensure environmental quality (e.g. Lund 2010).

4.2.6 Transferability

Given that the CDM is an offsetting mechanism to facilitate emission reductions in developing countries, the MRV system is already applied to developing countries. However, the CDM relies upon international institutions and capacity building would therefore be necessary if the MRV system would only be administered by developing countries.

4.3 Cement under the CDM and the Cement Sustainability Initiative

The proposed CDM methodology NM0302 "CDM methodology for cement and clinker production facilities based on benchmarking (version 2.0)" was developed by the Cement Sustainability Initiative (CSI), building on its voluntary protocol for calculating and reporting CO_2 emissions from the cement sector, The Cement CO_2 Protocol (the CSI Protocol). Because of the close similarity between these two MRV systems, this section analyses both systems together.

NM0302 is useful in understanding how the CSI Protocol has been adapted for a carbon offsetting purpose. As this study aims at providing recommendations for an MRV system for sectoral crediting mechanisms, our analysis on the MRV technicalities mainly focuses on NM0302. However, NM0302 lacks implementation experience because it was eventually rejected by the UNFCCC in May 2011. In order to complement this, we also analyse the implementation aspects of the CSI Protocol (e.g. data management, institutional framework). This is justified because NM0302 heavily relies on the CSI's cement plant database obtained through the application of the CSI Protocol (CSI's "Getting the Numbers Right" database, or the CSI GNR database).

NM0302 is applicable to CDM projects reducing GHG emissions from clinker or cement production facilities, be they newly constructed or already existent. Either a single or a combination of mitigation measures can be implemented, such as the substitution of fossil fuels by alternative fuels, the use of alternative raw materials, cement blending, energy efficiency improvements, electricity generation from waste heat recovery and renewable energy, etc. Because of this, this methodology is a good starting point for a MRV system for a whole sector.

The methodology uses a benchmark approach for the assessment of plant-wide emission performance, expressed in CO_2 emissions per ton of clinker or cement (tCO_2e/t clinker or cement). The benchmark is used for both baseline setting and additionality demonstration, but different stringency levels are applied for each of them (i.e. dual benchmark).

The baseline benchmark for existing plants is set as the emission performance at the top 45th percentile of the existing production volume in the region. The baseline performance of new plants is determined by two types of parameters: global and local parameters. The global parameters (specific heat and electricity consumption) are benchmarked at the top 45th percentile of the worldwide production volume of plants built in the last five years. The local parameters (fuel mix, calcinations and clinker to cement ratio) are strongly influenced by local conditions, thus they are benchmarked at the top 45th percentile of the existing production volume in the region. The additionality benchmark for existing and new plants is established in a similar way to the baseline benchmark, with an exception that the top 20th percentile is used as a benchmark stringency level. The benchmarks are updated every year according to the historical trend in the improvement of emission performance recorded in the CSI GNR database.

Leakage is determined by a simple, conservative approach. Emission reductions outside the boundary (e.g. reduced transportation) are not taken into account. Emission increases outside the boundary (e.g. increased transportation) are accounted for by a 5% downward adjustment of the emission reductions. Also, emissions from the cultivation of renewable biomass at a dedicated plantation are taken into account using a default leakage factor of 5 tCO_2e per TJ of biomass used in the project.

The required data are MRVed applying the CSI Protocol and registered in the CSI GNR database. The CSI retained PricewaterhouseCoopers (PwC) to design and manage independently the CSI GNR database to ensure accuracy of the information and adequate safeguards to protect confidential business information (WBCSD 2011a).

4.3.1 Environmental integrity

Completeness: NM0302 and the CSI protocol are highly complete in terms of the coverage of GHGs and emission sources within plants. Only very minor GHGs and emission sources are excluded (e.g. CO_2 emissions from combustion of wastewater injected into kilns, CH_4 and N_2O from kilns). However, as the benchmark parameters are calculated on the basis of the installations included in the CSI GNR database, the benchmark calculation is based on incomplete data of worldwide and regional production. This in turn affects the accuracy of the emission reduction estimations, as discussed below.

Consistency: The MRV systems do not contain any major source of randomness, so emission data should be comparable over time by using the same version of the MRV system. The CSI protocol is currently in its third version. The initial version, published in 2001, was field-tested for two years, reviewed and revised based on comments received from both users and reviewers (UNFCCC 2011a). The changes from the first to the second version were made to improve user-friendliness and adherence to the principles of relevance, completeness, consistency, transparency and accuracy (WBCSD 2005). The main change from the second to the third version was to address the need for accounting CO_2 emissions from on-site power generation, which was practiced in plants owned by new members of the CSI (WBCSD 2011b). The revision history of the CSI protocol shows that the MRV system has been revised to improve completeness and accuracy.

Accuracy: The reasons for the rejection of NM0302 explain where the MRV system lacks accuracy and conservativeness of emission reduction calculation. One key reason is that emission reductions through cement blending cannot be ensured by only monitoring the share of blended cement produced at the level of the project plant, as suggested in NM0302 (UNFCCC 2011a). If a cement plant increases the share of additives in its cement products, the availability of additives in the market decreases and could prevent other cement plants from using additives. In order to account for this leakage effect, one would need to monitor the share of blended cement produced by all cement plants in a relevant market. However, this solution is not feasible because the coverage of the CSI GNR database is still limited in many developing countries.

Conservativeness: The other key reason for the rejection is the deviation of the methodology from the benchmark stringency level stipulated in the Marrakech Accords (the average of top 20% performers). The CDM Methodologies Panel argued that such deviation could be acceptable only if there is no technology that can easily go beyond the benchmark, or if the percentage of plants that can go beyond the benchmark is very small, or if the level of incentives required for moving plants beyond the benchmark is huge as compared to the CDM incentive (UNFCCC 2011a). The methodology developer could not substantiate the choice of benchmark stringency with an analysis of real plant data.

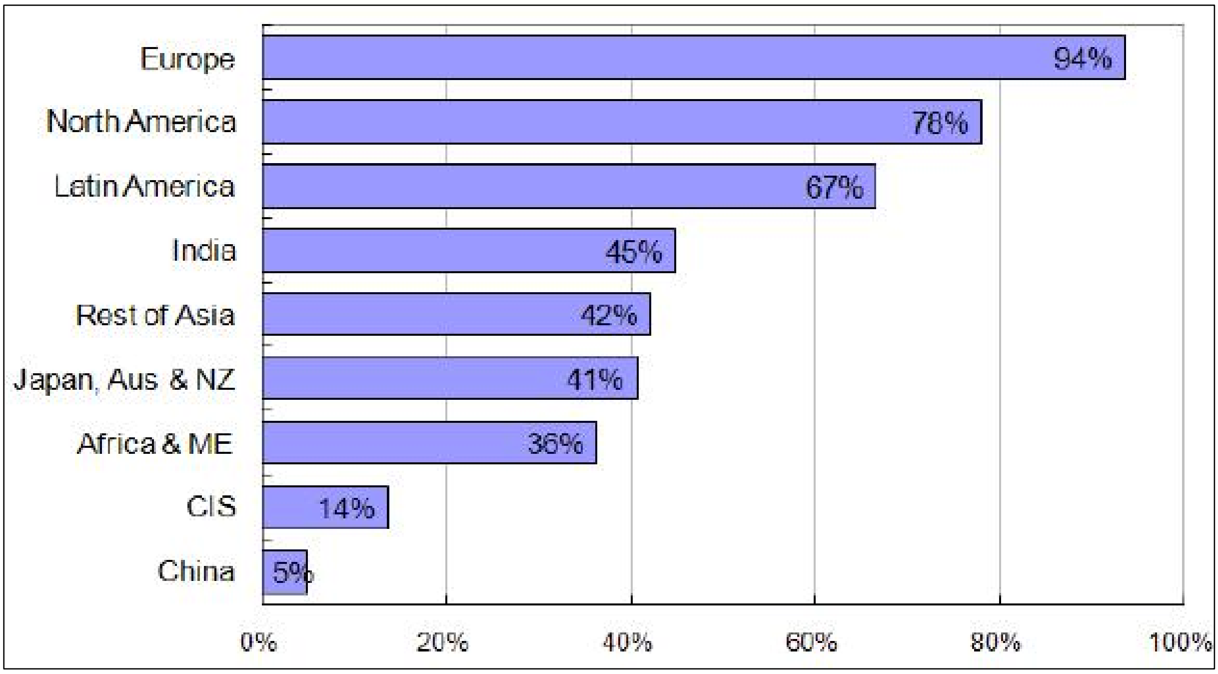
In summary, the environmental integrity of the two cement sector MRV systems analysed can be a concern. Although they are highly complete within plants and consistent, there are two major shortcomings that can lead to an inaccurate (or non-conservative) estimation of emission reductions: the unjustified choice of benchmark stringency and the inadequate treatment of cement blending activities.

4.3.2 Data availability

Data availability: The data required for the application of NM0302 (and the CSI protocol) are available for the following years: 1990, 2000, 2005, 2006, 2007, 2008 and 2009 (WBCSD 2011a). Early data (1990 and 2000) is less reliable than data for later years "since it had to be reconstructed up to 15-year old historical records of cement production, fuel purchases, company ownership, etc." (UNFCCC 2011a). Since 2006, the CSI member companies participating in the CSI GNR database have used an independent third party to verify their data at least every 3 years. Other participants to the CSI GNR database are strongly encouraged to adopt data assurance practices (WBCSD 2011a). As a result, 83% of the 2009 data is verified by independent third parties (WBCSD 2011a).

The CSI GNR database now covers over 900 cement plants, owned by 46 companies. This represents about 26% of the global cement production (WBCSD 2011a). The key challenge is that the CSI GNR database has limited data coverage in key developing countries (e.g. China, India, and the rest of Asia) (see Figure 1).

Figure 1: Regional coverage of cement production in the CSI GNR database in 2006



Source: WBCSD (2009a)

Anti-trust laws in Europe, the US and Japan require that collection of business-sensitive information be properly managed to avoid disclosure to competitors (WBCSD 2009a). The CSI GNR database complies with the anti-trust laws and is managed by an independent third party service provider (PwC). Confidential information on individual companies or plants is not disclosed, nor made accessible, and is protected by contractual and data security measures (WBCSD 2011a).

In addition, a Project Management Committee (PMC) was set up to serve as the single contact point for all communications between participants in the CSI GNR database and PwC. The PMC develops the schedule for companies' data submission to PwC and approves or rejects data queries submitted by stakeholders (WBCSD 2011a).

Data to be collected: The following data on emission and energy performance are collected (WBCSD 2011a):

- Specific gross and net CO_2 emissions per ton clinker and cement product;
- Absolute gross and net CO_2 emissions;
- Thermal energy consumption per ton clinker;
- Electric energy consumption per ton cement;
- Fuel mix (fossil fuel / fossil waste / biomass);
- Clinker to cement ratios.

To enable calculation of the percentiles, trend lines and correlations, the following information is also collected (WBCSD 2011a):

- Clinker and cement production volumes;

- Differentiation by grey and white clinker;
- Type of installation;
- Location of installation;
- Nominal production capacity;
- Year of construction.

4.3.3 Transparency

Public availability of emission and additional data: The results of the baseline and additionality benchmark analyses will be made publicly available. Due to the data confidentiality concerns, data obtained for individual plants cannot be disclosed. Thus, the benchmark results will be publicly available only at an aggregate level (i.e. regional level or country level for major producers such as China, India and Brazil) (UNFCCC 2009).

Upon approval by the PMC, other data in the CSI GNR database can be released to anyone, even outside the CSI membership. The PMC will review every data query, evaluating if the information is available and if response to the query would fall within the limits of the confidentiality and anti-trust constraints applicable to the CSI GNR database (UNFCCC 2009).

4.3.4 Cost-efficiency

Cost of MRV system: Existing CDM methodologies for the cement sector address only single measures. However, the implementation of a single measure yields only a limited amount of emission reductions in this sector. Thus, transaction costs, which mainly come from MRV, have been an important barrier for cement projects under the CDM (WBCSD 2009b). Against this background, the holistic MRV approach in NM0302 and the CSI protocol is expected to improve cost-efficiency of MRV systems for the cement sector because it streamlines MRV procedures and the combination of measures can achieve a higher amount of emission reductions.

There is no published data on the cost-efficiency of the application of NM0302 or the CSI protocol. However, the fact that over 900 cement plants have voluntarily participated in the CSI GNR database indicates that the application of the CSI protocol does not result in unreasonably high costs.

4.3.5 Institutional framework

Responsible authorities: On top of the CDM institutional framework described above under 4.2.5, the CSI GNR experience shows that it is indispensable to have an independent third party manage business-sensitive data. The database manager needs to ensure non-disclosure of confidential information and compliance with anti-trust laws. It is also helpful to have a body that is authorised to make decisions on data submission schedules and on disclosure of data to stakeholders.

The existing bodies (PwC, the PMC, independent auditors) have addressed these tasks since the start of the CSI GNR initiative in 2006. Thus, there is already a functioning institutional framework for the application of the MRV system.

4.3.6 Transferability

The CSI protocol has already been applied to plants in developing countries. Thus, the MRV system is in principle transferable to these countries. However, the limited coverage of the CSI GNR database indicates that there are some practical reasons why certain developing countries have not participated in the MRV initiative.

In the case of China, one of the key reasons for the limited data coverage is related to its cement market structure. The participants to the CSI GNR database are usually large, multinational companies. In contrast, the Chinese cement market is dominated by small- to medium-sized domestic companies, and the multinational CSI GNR participants are not present in the Chinese market (Müller 2011). Moreover, the smaller size of Chinese cement producers makes it more difficult to have an internal audit team to assure the quality of emissions and energy data collected (Müller 2011), which is an essential requirement for the participation in the CSI GNR database (WBCSD 2011a).

The MRV system is ready for use in any developing countries. However, the Chinese case shows that its implementation is easier in developing countries where there is a concentrated cement market with plants owned by large companies.

4.4 Buildings under the CDM

The methodology AM0091 "Energy efficiency technologies and fuel switching in new buildings (version 1.0.0)" is applicable to CDM projects that implement energy efficiency and/or fuel switching measures in new building units in the following categories:

- Residential: single-family, multi-family
- Commercial: office, hotel, warehouse, mercantile, etc.
- Institutional: education, public assembly, health care, etc.

A building unit is defined as a distinct space in a building allotted to a specific user, which can be either a tenant or owner. If a building is used by a single tenant/owner, the building unit is equal to the entire building.

A single benchmark is applied to baseline setting and additionality demonstration. That is, the stringency of baseline and additionality benchmarks is set at the same level. Thus, any emission reductions achieved beyond the benchmark are deemed additional. Only in the case fuel switching measures are implemented, additionality of these measures needs to be demonstrated by an investment analysis.

The benchmark is expressed in emissions per gross floor area (tCO_2e/m^2). Its stringency is set at the average emission performance of the top 20% performer building units in similar circumstances to project building units, which are built and occupied in the last five years. The similarity in circumstances is assessed by geographical location, climatic conditions, socio-economics status of building occupants, building unit type and size, and occupancy patterns.

The methodology evaluates the building emission performance at an aggregate (building unit) level. Therefore, one does not have to separately monitor every single measure implemented in each building unit (e.g., air-conditioners, compact fluorescent lamps, multi-glazed windows). The methodology can account for emissions from the consumption of electricity, fossil fuels, and chilled/hot water as well as refrigerant leakage (e.g. through refrigerators and air conditioners). The comprehensive coverage of efficiency measures and emission sources provides flexibility in choosing mitigation measures according to specific requirements of building units (Michaelowa & Hayashi *forthcoming*).

4.4.1 Environmental integrity

Completeness: Among the approved CDM methodologies available for the building sector, AM0091 has the most comprehensive coverage of GHGs and emission sources. The methodology monitors the total energy consumption of building units, without looking into the energy consumption of each energy efficiency measure implemented. As opposed to most other methodologies focusing on specific mitigation measures (e.g. efficient lighting, refrigerators), this technology-neutral approach has the advantage of accommodating a wide range of mitigation measures. The only major emission sources excluded from this methodology are the consumption of biomass and biogas. This is because complex procedures are necessary for calculating baseline and leakage emissions for these fuels. In order to avoid a possible emission increase from these emission sources, the methodology is made applicable only if the project building units do not consume biomass and biogas.

Accuracy and conservativeness: The technology-neutral approach requires a compromise in accuracy in the emission reduction calculation. As MRV is performed only at the building unit level, it cannot evaluate which mitigation measures result in how much emission reduction (i.e. weak causality between the measures and emission reduction). However, the stringent benchmark level set in the methodology (the average of the top 20% performers) would very likely result in a conservative estimation of emission reductions. Thus, the conservative benchmark acts as a safety valve for the environmental integrity. In addition, the methodology requires all measurement equipment to be calibrated according to relevant industry standards. The emission reduction estimates are conservatively adjusted for the measurement uncertainty as well as errors associated with building unit sampling.

Consistency: The methodology does not contain any major source of inconsistency. The methodology was approved in June 2011 and has not been revised since then. Thus, it is not possible to assess consistency in methodology revisions specifically for AM0091. In general, however, approved CDM methodologies are revised to improve conservativeness and accuracy of emission reduction estimation methods, or to improve the usability of the methodologies (UNFCCC 2010).

In summary, the methodology maintains a high level of environmental integrity. It has a comprehensive coverage of GHGs and emission sources, and provides proper justification for the exclusion of biomass and biogas usage. The technology-neutral benchmark approach needs a compromise in the accuracy of emission reductions estimation. But the conservative benchmark is expected to safeguard the environmental integrity. Though the methodology is yet to be revised since its initial adoption, its consistency can be expected to be high.

4.4.2 Data availability

Data to be collected: The benchmark approach applied in AM0091 requires extensive data. The key data for emission reduction calculation are gross floor area of building units (activity data), and energy consumption and refrigerant leakage (emission data).

Data availability: The gross floor area data need to be collected every third year from a sample of building units that is used for the calculation of baseline and project emissions. The data can be obtained from building plans or on-site measurement, if the former is not available. In developing countries, the data are not readily available. For example, in Abu Dhabi, the United Arab Emirates (where the CDM project underlying the development of AM0091 is situated), a building database is available with the Land and Real Estate Division of the Abu Dhabi Municipality. However, this database only has data about land area (plot plan) and designs, but not for the total gross floor area of building units. Thus, the data must be collected by building surveys (Prakash 2010).

The energy consumption data (electricity, fossil fuels and chilled/hot water) need to be collected every year. This is because annual variation in climatic conditions has a large impact on the building energy consumption. Such data are easier to obtain if the energy is supplied by local utilities and appropriate metering systems are implemented. This is likely the case with grid electricity supply and distribution of chilled/hot water through a district system. However, if the energy is purchased or generated individually by building unit occupants, it would be challenging to collect energy consumption data directly from the occupants (e.g. through energy purchase bills). This is more likely to be the case with captive electricity, fossil fuels (e.g. LPG, charcoal) and chilled/hot water supplied by individual systems within building units or by a central system captive to buildings. The refrigerant leakage data are to be collected every third year. But, if the actual monitoring is difficult, conservative IPCC default factors are allowed to be used.

Data confidentiality is less of a concern for the building sector than it is for the power and cement sectors. This is because building unit occupants, the key data source, are not market competitors as in the other sectors. The confidentiality issue may arise with the socio-economic data of building unit occupants, which are necessary for the identification of baseline building units. The socio-economic status can be measured by income levels of the occupants or property prices of the building units. Census data could be used if they contain income level information. However, such data are uncommon in developing countries. The methodology thus allows for the use of property prices as a proxy for income levels, which can be obtained through a real estate market survey without raising confidentiality issues.

4.4.3 Transparency

Public availability of emission and additional data: The methodology requires transparent documentation of all the steps for the calculation of baseline/project emissions, including a list of the baseline/project building units identified as well as the relevant data used for the calculation for the baseline/project emissions.

No CDM project has been submitted applying the methodology. Therefore, it remains to be seen to what extent project developers and validators fulfil the requirement of transparent documentation. But, compared to other carbon offset mechanisms, the CDM generally maintains a very high standard of transparency in the project data documentation. All key, non-confidential data are usually made publicly available, and confidential data, though not made publicly available, are communicated to the UNFCCC through DOEs for their assessment for project registration and issuance of CERs.

4.4.4 Cost-efficiency

Cost of MRV system: The methodology requires extensive data for the emission reduction calculation. Most of the key data are not readily available in developing countries. Furthermore, the methodology requires actual monitoring of data and offers only a limited number of default factors (e.g. refrigerant leakage). This is because building energy consumption patterns are heavily influenced by various local conditions (e.g. climate, geographic location, building size, occupancy patters). As it is difficult to establish widely applicable default factors, the methodology currently does not offer much scope for reducing MRV costs. Thus, MRV costs for the building sector would likely be very high. The methodology however allows to reduce costs by permitting the use of sampling in the data monitoring process.

Another option for reducing MRV costs lies in the possibility of proposing a Programme of Activities (PoA). This can be achieved by allowing for bundling of an unlimited number of CDM Project Activities (CPAs), and by simplifying procedures for registration of CPAs (CPAs can be added to a PoA without assessment by the UNFCCC) and for verification of a PoA (one could opt for verification of a sample of CPAs). PoAs are especially relevant to the building sector because it involves a number of small and dispersed emission sources.

4.4.5 Institutional framework

Responsible authorities: In applying AM0091, key steps of the monitoring and reporting stages are (1) identification of baseline building units for benchmarking, and (2) monitoring of energy consumption of the baseline/project building units. The institutional framework required for these steps are described below. The verification stage is addressed by the regular CDM bodies such as DOEs and the CDM Executive Board. Thus, it is not discussed below.

The identification of baseline building units requires building surveys for collecting the necessary information on building unit characteristics. The data collection effort can best be built on the existing database and data collection procedures of local government bodies responsible for issuing permits to new building constructions. Such bodies may have better access to income level information in census data, if such are available. If the income level data are not available, the government bodies need to work closely with real estate agencies regularly collecting building property price information.

The monitoring of building energy consumption requires a close collaboration with local utilities supplying electricity, fossil fuels and chilled/hot water to baseline/project building units. Their regular metering procedures can be adapted to the methodology application (e.g. use utility bills). In the case the energy is purchased or generated in a decentralised manner, the energy consumption data need to be collected directly from building units occupants. There is no existing body exercising such data collection, thus a new institution needs to be created for this building survey.

4.4.6 Transferability

The methodology is suitable for advanced developing countries that have the capacity to implement the rather demanding MRV system, and where building units consume modern energy carriers.

The implementation of the MRV system is easier if local utilities have already implemented appropriate metering of building energy consumption, and records of new building constructions are maintained centrally. It is also helpful if a census survey is carried out regularly on income levels. Otherwise, there should be a functional real estate market so that building property prices can be obtained.

It is best if the building units consume modern energy carriers (e.g. electricity) because they are usually distributed by central energy suppliers and MRV of their consumption is easier. In addition, the methodology currently does not allow for the use of biomass and biogas. As they are essential energy carriers for less advanced developing countries, the methodology requires a revision to be applicable to these countries.

5 Proposals for MRV of new market-based mechanisms

This chapter describes the main institutional and data requirements for a MRV within NMBM. The proposals are based on the analysis of existing systems (CDM, EU ETS) in the chapters before and the existing literature. Taking our criteria from the introduction the main requirements for a MRV system are environmental integrity (completeness, accuracy and consistency of data), transparency and cost-efficiency.

5.1 Institutional requirements

A well-functioning MRV system will need a series of domestic (host country) and international institutions. We describe here the *minimum of institutions needed for a credible MRV system* within NMBM, while we do *not* discuss the institutions needed for the implementation of new market-based mechanisms (e.g. planning and implementing policy measures, and translating the price signal to the private sector).

5.1.1 In-country institutions

In NMBM, host country institutions will have a central role in monitoring and reporting, while they may also participate in verification. The role of domestic institutions is similar to that in the EU ETS and more important than in the CDM case (because of the policy-nature of NMBM and the sectoral scale). Each host country will need at least a national coordinating entity (NCE) and regulations, and in many cases also technical intermediaries and national verifiers.

- A **National Coordinating Entity (NCE)** is needed for coordinating the baseline assessments, national monitoring and reporting, reviewing the data quality, and approving the sectoral programme proposals as well as monitoring reports before sending them to international institutions. The NCE will help to avoid overlaps of different sectoral programs, coordinate all in-country institutions (see the experience of the EU ETS and the cement sector) and assure consistency of data from different sources and with the national GHG inventory. Incorporating the NCE in the CDM's Designation National Authority (or the other way round) is not necessary but has the advantage of sharing information and building on existing capacity.
- **Regulations and administrative procedures** (here also seen as institutions) are also required for a MRV system to function. New market-based mechanisms will cover the emissions of multiple private (and public) entities, which have to be obliged to monitor

and report their emissions (Aasrud et al. 2010; Duggan 2010). The way this is achieved (only national or also subnational, soft or hard rules) will be country- and sector-specific.

- **Technical Intermediaries (TIs)** will in most cases also be needed because of several reasons. First, some of the emitting entities will not have the capacity to monitor and report their emissions on their own (see the experience of the building sector in the CDM). Therefore, local governments, utilities or consultants will have to collect data. Second, TIs may be needed in aggregating local data and assuring data quality, as the NCE itself may not have the outreach or capacity to assure accurate and complete data country-wide. Depending on the national circumstances, the TIs can be private and/or public, split in many institutions or unified in one body.
- **National Verifiers** will be most important in the case of decentralized governance of NMBM, where only generic guidelines and rules are decided on the international level, while concrete MRV is undertaken at the national level (and only loosely reviewed on the international level). As learned from the EU ETS and the cement sector, independence of theses verifiers is needed to ensure confidentiality.

In most countries and for all described institutions, substantial capacity has to be built for the MRV system to operate smoothly (see Schneider and Cames 2009; Aasrud et al. 2010, Duggan 2010; Fujiwara et al. 2010; World Bank 2010). The Table below shows that a pre-assessment needs to be undertaken before capacity is built and systems have to be tested before implementation. These three steps are interactive; learning-by-doing will enable capacity building over the long term. We can derive from lessons under the CDM that capacity building programmes have to be coordinated and linked to concrete programme/project proposals to increase effectiveness (Okubo & Michaelowa 2010: Stadelmann & Michaelowa 2011).

Capacity building area	Specific steps
Technical capacity building	Pre-assessment of data requirements, data availability and collecting capacity (Schneider & Cames 2009; Duggan 2010; Fujiwara et al. 2010; World Bank 2010)
	Capacity building on collection, reporting and verification of reliable data (Duggan 2010; Fujiwara et al. 2010)
	Testing of MRV systems (Aasrud et al. 2010; Fujiwara et al. 2010)

Source: Extracted and adapted from a table in Stadelmann & Michaelowa (2011)

5.1.2 International institutions

At the international level, institutions are needed to review the proposals of sectoral schemes and, in the case of an internationally coordinated system, to verify baselines, emissions and to issue credits. Learning from the CDM, we suggest that there is at least a governing body, a technical body, an administrative support unit, while verification may be conducted by independent verifiers.

- A **governing body** (similar to the CDM Executive Board) should decide on politically sensitive issues, such as the main MRV guidelines. In the case of an internationally coordinated governing system, as lined out by the EU in their proposal of a “Special Supervisory Board" (UNFCCC 2011c), this body will also approve methodologies, sectoral programme documents (including crediting baselines, programme design) and verified monitoring reports, and will issue credits. In the case of an uncoordinated system, the body will just provide an analysis of reported information. While it would be theoretically desirable to have an independent non-political body, the politically sensitive nature of decisions will in the end require balanced representation of experts from developed and developing countries. Learning from the CDM, it is important that the governing body is professionalised once the workload increases. It can lower its workload by focusing on politically sensitive decisions (e.g. crediting baselines, see Schneider & Cames 2009), while delegating technical analysis to other bodies.

- **Technical bodies:** The technical bodies will carry out the technical work that exceeds the capacity of the governing body (similar to the CDM Methodology Panel, Accreditation Panel, Small Scale Working Group and Registration & Issuance Team). In an internationally uncoordinated governing system, the technical bodies will mainly elaborate guidelines and analyse the information on NMBM submitted by Parties (e.g. MRV system, achieved reductions, traded credits), while in an coordinated governing system the technical bodies will also elaborate baseline and MRV methodologies, and assess critical information in programme documents (e.g. crediting baselines). De Sépibus & Tuerk (2011) argue that programme-specific analysis will have to be undertaken also on the ground, in interaction with national stakeholders, to better understand the data and country circumstances.
- **Accredited verifiers** (similar to DOEs in the CDM) will probably be needed in the case of an internationally coordinated governance system, as assessing all information will exceed the capacity of the technical bodies. Two lessons on independent verifiers can be learned from the CDM: First, they should only be responsible for data that is easily verifiable (e.g. data on fuel use, calibration of measurement equipment, compliance with procedures) while politically and technically challenging tasks (e.g. assessing a counterfactual baseline) have to be undertaken by technical bodies under political guidance. The second lesson is that verifiers should not be directly appointed and paid by the sectoral programme owner (the host country) but appointed by international bodies (see e.g. Lund 2010).
- An **administrative support unit** would receive, stores and forward documents, in order to facilitate the work of the governing and the technical bodies.
- Last but not least, **overarching institutions** are needed to integrate the units generated by NMBM into a broader GHG accounting framework. While the Kyoto Protocol encompasses those institutions, including the international carbon unit, the international transaction log (ITL) for credits, and national registries for emission allowances, it is unclear if these institutions will continue to exist as the fate of the Kyoto Protocol is uncertain and the negotiations under the UNFCCC do not provide clear signals whether Kyoto institutions will be maintained. For assuring an environmentally integer MRV system for NMBM, the existing institutions have to be continued and a sound link to new MRV elements, including International Consultation and Analysis (ICA) as well as MRV of NAMAs has to be established (de Sépibus & Tuerk 2011).

- Additionally, an **appeal body** may be required, in order to enable stakeholders to appeal against decision of the governing body (see experience within the CDM)

5.2 Data requirements

5.2.1 Data required for environmental integrity

NMBM can build on the experience of the CDM and EU ETS, when defining the type of data needed. The minimum information required in any sectoral programme document should encompass the following;

- Definition of scope of sector, covered greenhouse gases and installations (Aasrud et al. 2010)
- Past and current emissions, including data sources, methodologies and tools; link to inventory data
- Projected business-as-usual emissions and assumptions (e.g. growth, technological change)
- Proposed sectoral policies and measures, including expected GHG impact and financing
- Proposed crediting baseline (in the case of sectoral crediting) or emission cap and allocation (in the case of sectoral trading)

Information required in any monitoring report should encompass the following;

- Measured emissions, including data sources, methodologies and tools; link to inventory data
- Implementation of sectoral policies and measures, estimated GHG impact and financing
- Calculation of emission reductions (compared to baseline)

5.2.2 Methodology approach

The information requirements listed above are just broad data categories. In practice, each sector or sub-sector will require methodologies on the detailed type of data needed, guidance for data collection and formulas for combining the numerous variables. These methodologies will have to be updated or revised once better evidence for emission calculations is present. For this substantial challenge of setting up and revising methodologies, NMBM can build on existing methodologies of the CDM, but the challenge will be to adapt the largely single-measure and project-based methodologies to holistic ones that can assess emissions and baselines of entire sectors and can accommodate several measures. The CDM methodologies closest to sectoral methodologies are the ones in the power, cement, and building sector. In addition, lessons can be drawn from the EU ETS, mainly in terms of emissions data monitoring in industrial sectors and in terms of determining sectoral benchmarks.

5.2.3 Accuracy versus flexibility

We have set out in the beginning that any credible MRV system should ensure completeness, accuracy and consistency of data, in order to warrant environmental integrity. However, we can learn from the EU ETS and the CDM that highest accuracy sometimes has to be traded for practicability and flexibility, but should not be traded for conservativeness. As the question of accuracy vs. flexibility/practicability in NMBM will certainly come up in the future, the governing body will be better off considering this from the beginning. We propose the following rules of thumb, derived from lessons in the EU ETS;

- **Flexibility at the beginning**: to trigger early deployment of NMBM and enable capacity building and learning, NMBM should only demand full accuracy and completeness if the host country has enough capacity. The tiered approach for accuracy of data as applied in the case of the EU ETS is an interesting tool to be applied in NMBM, which may also enhance cost-efficiency of MRV systems. In order to create financial incentives from the outset, NMBM should receive fully fungible units right from the beginning, but to ensure conservativeness part of these credits should be cancelled or not issued at all.
- **Strict rules in the mid-term**: Some years after NMBM have started, the governing body should try to tighten the rules and ensure full environmental integrity of NMBM, in order to enhance credibility and ensure net emission reductions (see Michaelowa 2009 for the case of the CDM). This phase will also allow for testing the level of environmental integrity that is achievable.
- **Flexibility in the long term:** After 7-10 years of operation, existing NMBMs will have to consider the lessons learned from the pilot phases: which data is absolutely required, where can more flexibility be allowed? Are there still loopholes in environmental integrity? A reform of NMBM will probably be required, similar to the reforms after Phase I and II of the EU ETS.

5.2.4 Confidentiality

Particularly the Cement Sustainability Initiative but also discussions in the aluminium and steel sector have shown that confidentiality of industry data can be a hurdle for data collection. Therefore, only accredited verifiers and technical bodies should be allowed to view and analyse installation-level data after having signed confidentiality clauses, while only showing aggregate data to the public. This certainly contradicts full transparency, which may lower political acceptance. A fine balance between confidentiality and transparency has to be found.

6 Conclusions

Accurate monitoring, reporting and verification (MRV) of emission reductions is an essential element for ensuring environmental integrity of new market-based mechanisms (NMBM), which have the double goal of better integrating developing countries in the global carbon market and enabling cost-effective mitigation for industrialised countries. The creation of a sound MRV system can be accomplished by ensuring completeness, accuracy and consistency of data through the setup of both domestic and international institutions and detailed but realistic rules for data collection.

The shaping of MRV systems for NMBM can draw lessons from three existing systems: First, the Clean Development Mechanisms (CDM) as the only established carbon market mechanism involving developing countries. The CDM can provide a good starting point with its established methodologies, rules and institutions but the framework has to be adapted when moving from the project to the sectoral level (e.g. the role of national MRV institutions will be more important). Second, the European Union Emission Trading Scheme (EU ETS) as the largest and technically most advanced ETS worldwide provides important lessons for the setup of institutions and MRV of data at the sectoral and national level (e.g. flexibility needed, tiered approach of data accuracy, role of national institutions). However, the availability of data and capacity for accomplishing MRV functions will be different in developing countries, and the EU ETS is more similar to some NMBMs (sectoral trading) but rather different to other (sectoral crediting). Third, new data collection, reporting and verification systems for developing countries are being currently negotiated: MRV of internationally supported Nationally Appropriate Mitigation Actions (NAMAs), International Consultation and Analysis (ICA) of non-supported NAMAs and procedures for biennial update reports including national inventories. While all these systems are not yet implemented, the MRV of NMBM should be consistent with these systems to avoid double counting and overlaps.

From the analysis of the EU ETS and CDM methodologies covering data of whole sectors (buildings, cement and power), we derive the following institutional and data requirements for a credible MRV system of new market-based mechanisms:

Regarding institutions, various national and international institutions will need to be created. Particularly the national ones will be important, very similar to the EU ETS, as data from whole sectors has to be monitored and reported. We assume that at least a national coordination entity and national regulations are required. In addition, technical intermediaries for data collection and aggregation as well as national verifiers may be needed. Most institutions will require substantial capacity building, which should be combined with concrete sectoral programmes and start as early as possible.

At the international level, we propose to establish an institutional architecture that is very similar to the one of the CDM: a governing body taking politically sensitive decisions, several technical groups as well as an administrative support unit assisting the governing body, and internationally accredited verifiers, who are responsible for time consuming tasks and easily verifiable data. The concrete role of bodies will very much depend on the post-2012 architecture of the climate regime. In the case of an internationally more coordinated MRV system, the technical bodies will do detailed work on methodologies, rules and approval of verifiers, while their tasks would be limited to elaborating general guidance and analysing (or reviewing) submitted information of national NMBM in a decentralized system. Und a lesser coordinated approach, the governing body would only be approving the work of the technical bodies, while under the internationally coordinated approach the governing body has to take much more important decision on caps and crediting baselines.

Regarding data requirement, we assume that proponents of a sectoral programme would have to submit at least information on emission coverage, current and projected emissions, proposed caps or crediting baselines, planned policies and measures, expected impact and funding, as well as actually measured emissions. Detailed data requirements would have to be elaborated in sector-specific methodologies, which can partly build on methodologies and data in the CDM, particularly in the cement, building and power sector. Experience from the CDM and the EU ETS illustrates that an encompassing data collection system can create substantial transaction costs. In order to encourage the short-term implementation of NMBM, flexibility in terms of tiered data requirements may be needed, which however need to be strengthened with increasing experience and hence data availability. While providing flexibility is key also to reduce transaction costs, conservativeness of emission reduction estimations should not be compromised. Finally, confidentiality of data will be a hurdle in competitive industries, so a system to balance transparency and confidentiality has to be elaborated.

The most important conclusion is that MRV of NMBM will very much depend on the outcome of the climate negotiations, mainly whether NMBM are governed internationally coordinated or not. An internationally coordinated MRV system would more easily ensure environmental integrity because of common rules and accounting. However, a rather uncoordinated system is not unlikely given the current negotiations. Therefore, more analysis has to be done on institutions and MRV guidelines required to ensure a minimum of environmental integrity of NMBM in the case of an internationally uncoordinated regime. De Sépibus & Tuerk (2011) have made some first attempts by emphasising the importance of international reviews of NMBM documents in the case of uncoordinated governance.

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