Annex 13

Recommendation on CO_2 capture and storage as CDM project activities based on the review of cases NM0167, NM0168 and SSC_038

Executive Summary

This recommendation is based on the assessment of three proposed new methodologies for CCS (carbon dioxide capture and storage) project activities and identifies a number of issues related to CCS project activities under the CDM. The identification of issues is based on the qualitative assessment by the CDM Executive Board, the Meth Panel, and the desk reviews of the cases NM0167, NM0168 and SSC_038.

The approaches and procedures suggested by the submitted methodologies do not address the methodological and accounting issues in an appropriate and adequate fashion. This would therefore pose considerable difficulties in approving these proposed methodologies as CDM methodologies in their current form. In addition, it is questionable whether some issues can be resolved without further guidance from COP/MOP and/or a technical body on CCS.

Two categories of methodological issues have been identified: i) methodological issues that are comparable in nature to those faced by other proposed CDM methodologies – identification of alternative scenarios and baseline selection, analysis of additionality and carbon dioxide leakage/seepage, calculation algorithms for baseline emissions, project emissions and emissions reductions, sub-national project boundary questions, and so forth and ii) issues that go beyond the nature of other proposed CDM methodologies, i.e. issues that lie at the frontier of scientific knowledge or engineering practice (site selection criteria, monitoring methods), or that present unique accounting or liability challenges (permanence, i.e. implications of accidental, unanticipated or intentional future releases of stored CO_2 from the reservoir).

Among the issues in point (ii), that go beyond the nature of other proposed CDM methodologies, it may be helpful to differentiate between A) policy or legal issues and B) issues of largely technical nature. Based on the assessment of the methodologies, the following issues have been identified:

A. ***Policy or legal issues***:

- Acceptable levels of long-term physical leakage (seepage) risk and uncertainty (e.g. less than X% seepage by year Y with a likelihood of Z%);

- Project boundary issues (such as reservoirs in international waters, several projects using one reservoir, etc) and national boundaries (approval procedures for projects that cross national boundaries);
- Long-term responsibility for monitoring the reservoir and any remediation measures that may be necessary after the end of the crediting period (i.e. liability);
- Accounting options for any long-term seepage from reservoirs (e.g. new modalities and procedures such as those for LULUCF).

B. Issues of a largely technical and methodological nature, which require geological, petroleum engineering, and other specific expertise in order to address. These include:

- The development of criteria and a step-wise guidance for the selection of suitable storage sites with respect to the release of greenhouse gases, and how this relates to applicability conditions for methodologies;
- Guidance on the development of adequate and appropriate monitoring methodologies for physical leakage (seepage) from the storage site;
- Guidance related to the operation of reservoirs (e.g. well sealing and abandonment procedures) and remediation measures and how these may need to be addressed in baseline and monitoring methodologies.

It is important to emphasize that the resolution of these technical and methodological issues, in particular the suitability of storage sites, depends also upon guidance with respect to policy and legal issues, in particular on acceptable levels of long-term physical leakage (seepage) risk and uncertainty.

Section 1 provides a brief summary of the three proposed methodologies (1 small scale and 2 large scale) qualitatively considered by the Meth Panel and SSC WG. Section 2 provides a more complete discussion of the crosscutting issues raised by the three proposed methodologies that go beyond the nature of issues arising from other CDM methodologies, as noted above. Section 3 describes the key findings of the qualitative assessment of the methodologies by the Meth Panel and SSC WG, as they relate to standard CDM methodological issues (e.g. baseline scenarios, leakage, etc.) and Section 4 provides a brief conclusion.

1. *Summary of submitted projects / methodologies*

NM0167 (CDM-PDD: "The White Tiger Oil Field Carbon Capture and Storage (CCS) project in Vietnam") addresses project activities that capture CO_2 from a power plant and transport it by pipeline for injection into geological reservoirs, including the use in Enhanced Oil Recovery (EOR) operations. The project boundary includes capture, transport, injection, where relevant, EOR installations, and the storage reservoir, but excludes the power plant. Emissions leakage is assumed to be negligible (the question of whether the additional oil recovered might or might not affect global emissions is not discussed). The methodology proposes that if physical leakage (seepage) is below 0.1% per annum[1], the emission reductions from the project activity are deemed permanent, and if seepage is higher, permanence is assumed to be insufficient in which case all CERs arising from the project activity are cancelled. Monitoring is done primarily by direct measurements at the injection point, and underground via 4D seismic analysis. The baseline is continued Enhanced Oil Recovery with seawater. Site selection is done according to criteria provided in an IEA GHG R&D Programme publication on CCS[2].

NM0168 (CDM-PDD: "The capture of the CO_2 from the Liquefied Natural Gas (LNG) complex and its geological storage in the aquifer located in Malaysia" addresses project activities that capture a mixture of waste acid gases from natural gas processing plants and liquefied natural gas (LNG) plants and stores this gas mixture, which consists primarily of CO_2, in underground aquifers or abandoned oil/gas reservoirs. In order to sell the gas, the CO_2–rich acid gas must be separated and removed. Separation (capture) facilities are therefore not included in the project boundary, which comprises of compression, transport and the storage reservoir. Physical leakage (seepage) is estimated based on monitoring procedures, which involve the monitoring of the CO_2 stream into the reservoir and the potential seepage paths identified through seismic measurements. The baseline is the incineration of the acid gas rather than the storage underground. For site selection criteria, the methodology refers to numbers in the IPCC Special Report on CCS (SRCCS) that have been incorrectly interpreted as a performance norm. Permanence is accounted for by discounting CERs for seepage beyond the crediting period based on an ex-ante estimated seepage rate.

SSC_038 ("Anthropogenic ocean sequestration by changing the alkalinity of ocean surface water (alkalinity shift") addresses project activities that use CO_2 from power station flue gases and pump it through flowing seawater in which limestone in porous baskets is placed. The resultant reaction converts the CO_2 contained in the flue gas to bicarbonate. Only a fraction of the flue gases pumped in this way will be neutralised and remains in solution. This fraction varies but is expected to be about 50%. The project boundary is the physical boundary of the power station and cooling water channel, and extends into the sea, where the boundary is delineated by a 20 km radius from the cooling water discharge point. Leakage may occur through the use of additional electricity to achieve a constant flow rate past the limestone cages. Monitoring comprises the measurement pH, temperature and the estimation of Dissolved Organic Carbon[3] .

[1] In the methodology, this is explained as follows: A figure of 1000-year permanence is the most commonly quoted in reports concerning CCS. This is equivalent to a seepage rate of 0.1%/yr or 0.7% for a 7-year crediting period. Projects in strict compliance to the applicability conditions of this methodology can claim "permanent storage of CO_2". Note that assuming a seepage rate of 0.1% per year about 63% of the CO_2 stored would be released after 1000 years.

[2] IEA Greenhouse Gas R&D Programme. 2003. *Barriers to overcome in implementation of CO_2 capture and storage (2): Rules and standards for the transmission and storage of CO_2*. Report number: PH4/23.

[3] Based on an unpublished manuscript of the US Department of Energy (1994).

2. *General methodological issues arising from CCS project activities under the CDM*

The following section describes general methodological issues that go beyond the nature of other CDM project activities, i.e. that lie at the frontier of scientific knowledge or engineering practice or that present unique accounting or liability challenges related to CCS activities. The section also notes how these issues arise in the submitted methodologies NM0167 and NM0168. (SSC_038 is a very different proposal from geological storage of CO_2 and gives rise to concerns regarding permanence and monitoring. Where appropriate, those concerns are also mentioned.)

2.1. Physical leakage (seepage)

1. **Site selection criteria for geological reservoirs.** Criteria for selection of suitable geological CO_2 storage sites aim at distinguishing reservoirs that are able to contain the CO_2 for sufficiently long timescales from reservoirs that are likely to leak to an unacceptable extent. Appropriate site selection is mentioned as one of the conditions for suitable geological storage projects in both the IPCC Special Report on CCS and the 2006 IPCC Guidelines, but is not specifically defined. Methodologies NM0167 and NM0168 suggest that site selection criteria be used as applicability conditions in order to limit the risk of future seepage from the reservoir.[4] The proposed provisions as currently specified in the methodologies are insufficient, as they do not provide a (step-wise) *procedure* for assessing the quality of a site nor do they provide clear and transparent *criteria* that could be validated by a DOE in an objective manner. NM0167 lists data that should be collected in order to assess a site but does not provide guidance how the risk of seepage should be assessed based on these data. NM0168 suggests the use of the expected fraction of carbon dioxide retained after 100 and 1000 years within the reservoir as a site selection criterion, based on figures stated in the IPCC SRCCS. However, the IPCC figures given for appropriately selected and managed geological reservoirs are estimates of the performance of CO_2 storage reservoirs in general. They should not be used as a performance norm for storage sites as these figures do not represent a guideline or definition for maximum acceptable seepage rates.

   The site selection criteria could be further elaborated by the project participants, but it may be very difficult to arrive at acceptable standards on their own or for the Meth Panel to provide sufficient review. As a number of parties and observers have suggested, an expert group (or the IPCC) may be better equipped to deal with the key technical issues, and to achieve a reasonable balance of upfront prescription and site-specific flexibility.

2. **Monitoring methods for seepage emissions.** Reviews of NM0167 and NM0168 suggest that the proposed monitoring methodologies are insufficiently specified. For example, NM0167 contains many lists of variables that might be monitored, but little indication of how the monitored results would be used to determine project or baseline emissions. Indeed, given the ongoing evolution of CCS monitoring techniques and models, a fully elaborated monitoring methodology may be premature at this point. It may be difficult to follow the standard procedures for new methodologies, which require a monitoring methodology sufficiently detailed that a DOE can validate and verify it. Effective monitoring of CCS projects might require a regularly evolving set of protocols that reflect the latest scientific and engineering knowledge.

[4] For SSC_038, site selection criteria appear irrelevant with regard to physical leakage (seepage). Seepage rates are expected to primarily depend on depth of injection rather than site-specific characteristics of the ocean.

Examples of specific issues arising in NM0167 and NM0168 that are at the frontier of scientific understanding and beyond the CDM procedures include:

- **Anticipating post-project seepage.** With respect to NM0167, there is a nearly exclusive focus on measurable seepage during the crediting period. As noted by various experts and desk reviewers, it is important to monitor underground flows and to anticipate future seepage and not just to consider what might occur during the crediting period (the latter is better addressed by NM0168.). The corrosive effects of CO_2 on the caprock and on old well bores or abandoned project wells are mentioned but not evaluated.
- **Difficulty of accurately assessing seepage**. According to one desk reviewer, current monitoring techniques appear unable to accurately determine seepage from a reservoir and, as for NM0167, such an inability would mean that no CERs can be generated (see below). However, as noted by the same reviewer: "If a reservoir is carefully selected according to strict site selection criteria, it is highly unlikely that seepage will occur. It might therefore be better to focus on site selection rather than on monitoring techniques in the case of CCS project activities."
- **Determining appropriate monitoring methods.** NM0168, for example, relies exclusively on seismic 3D surveys to monitor seepage. These surveys may assist in determining movement of significant volumes of CO_2 and in finding potential seepage paths, but is not sufficiently accurate to determine CO_2 volumes emitted through seepage as compared to the volumes of CO_2 in the reservoir. One desk review suggests that other methods may be needed, such as side-scan sonar, CO_2 buoy network in monitoring area, seabed monitoring (if stable seabed conditions), soil monitoring (onshore only), sniffing (onshore), bubble monitoring (offshore), remote sensing (aircraft or satellite). NM0167, for example, does not consider the monitoring of methane in soil gas, and impurities in the injected CO_2, and analysis of potential seepage routes. Overall, it may be difficult to generically specify which monitoring methods should be used and where.

In summary, the monitoring of geological CCS projects may require a process adapted to the unique, evolving circumstances of this project type, as well as the heterogeneity of storage sites. Similar to site selection criteria, developing and reviewing monitoring approaches for CCS (whether discrete methodologies or general guidance) requires specialized expertise, and a balance between general prescription (to ensure integrity) and site-specific flexibility (to recognize the evolving and diverse possibilities for monitoring techniques, and the geological uniqueness of each storage site). The role of DOEs, the level of prescription for methodologies and the potential role of sectoral experts need to be carefully considered.

Monitoring in the small scale CDM proposal (SSC_038) comprises the estimation of the amount of CO_2 reduction through pH and temperature measurements and estimation of the amount of Dissolved Inorganic Carbon (DIC). The documentation does not mention monitoring of potential leakage.

3. **Acceptable levels of seepage emissions.** A key question for methodologies for CCS project activities is what long-term levels of physical leakage (seepage) risk and associated uncertainty is acceptable. NM0167 proposes a threshold approach for seepage rates that act both as an ex-ante indicator for an acceptable level of *expected* seepage rates, and as an ex-post indicator of continued project eligibility. It is proposed that seepage of CO_2 shall not exceed 0.7% of the total stored amount

in a single 7-year crediting period or 1.0% in a 10-year fixed crediting period[5]. NM0168 suggests that seepage of CO_2 "is very likely" to be less than 1% in 100 years and "is likely" to be less than 1% in 1000 years based on the IPCC SRCCS assessment. Hence, the proposed thresholds differ significantly between the two methodologies, both in their specifications and in their application.

Experts, including those involved in the IPCC SRCCS assessment, have also indicated that reservoirs may leak in different ways. Release of CO_2, if it happens, may be the result of sudden events (such as well blowouts), it may be gradual, or combinations of these possible variants. Seepage may also only occur after the crediting period. The question of "acceptable levels of seepage emissions" expressed in an annual seepage percentage may therefore not bear any relation to the reality of the operation, or at best be only an approximation of the actual seepage taking place.

The selection of an acceptable level of expected future seepage emissions, including the way it is expressed, and of an acceptable level of uncertainty are difficult *policy* choices that have implications for the long-term stabilization of GHG emissions in the atmosphere and hence go far beyond other typical CDM methodological issues.

4. Key questions related to seepage:

- What are reasonable site selection criteria and which entity should develop a procedure and criteria for selection of storage sites?
- What are appropriate monitoring methods, given the differences in the characteristics of storage sites, and which entity should develop guidance on monitoring?
- Given the limitations in the current ability to directly measure and track the underground volume of injected CO_2 and to accurately measure any seepage, what are the likely uncertainties in monitoring seepage?
- Are these significantly larger than the uncertainties in other CDM methodologies, and if so, how can they be addressed?
- How should seepage emissions that are difficult to monitor be addressed (e.g. abrupt emissions due to natural events)?
- What is a workable unit for seepage? Is the concept of seepage threshold an appropriate concept for site selection (ex ante) and/or for project eligibility (ex post), and, if so, what are the appropriate threshold(s)? If not, what are the alternatives?
- What are acceptable levels of long-term physical leakage (seepage) risk and uncertainty (e.g. less than X% seepage by year Y with a likelihood of Z%)?

2.2. Permanence and liability

The potential seepage of CO_2 from a geological reservoir raises a number of questions related to the permanence of emission reductions from potential CCS CDM project activities. There are different ways seepage emissions from the reservoir could be taken into account with both NM0167 and NM0168 distinguishing between seepage emissions occurring during the crediting period and occurring after the end of the last crediting period.

[5] According to a footnote in the methodology, these numbers are based on an assumed "accepted storage time" of 1000 years. The project participants interpret this as "All CO_2 is allowed to gradually seep out of the reservoir over a period of 1000 years". This results in a seepage rate of 0.1% per year.

5. **Seepage emissions during the crediting period.** NM0167 proposes that, for any seepage emissions beyond the proposed threshold (0.7% during a 7-year crediting period or 1.0% during a 10-year crediting period), CERs will be replaced by project participants with other valid units. If seepage emissions cannot be determined accurately, all CERs issued shall be cancelled and those already used for compliance in previous commitment periods would be replaced with the equivalent amount of CERs, ERUs and AAUs.

   NM0168 proposes that, for any seepage emissions, CERs would be replaced by project participants with the equivalent amount of CER/ERU/AAU.

   These proposals appear to require an amendment of accounting and registry provisions under the Kyoto Protocol.

6. **Seepage emissions after the end of the last crediting period.** NM0167 does not address how to account for CO_2 seepage emissions after the end of the final crediting period, but suggests that monitoring of seepage should continue after the end of the crediting period for those projects with a history of significant seepage of stored CO_2.

   NM0168 involves the prediction of long-term seepage emissions, e.g. over 1000 years, using the best available knowledge and data. The amount of project emissions due to long-term seepage is supposed to be determined considering a discount factor; however, this discount factor is not specified in the methodology.

   Neither proposed methodologies (NM0167 and NM0168) addresses how it would be ensured that any necessary remediation measures after the end of the crediting period would be undertaken. It was noted that some proposals to address this issue (temporary CERs, pooled insurance) would appear to require an amendment of accounting and registry provisions under the Kyoto Protocol, while others raise questions related to legal liability.

7. **Key questions related to permanence and liability for geological storage projects:**
   - How should (non-trivial) seepage emissions from storage reservoirs be accounted for (during and) after the end of the last crediting period or before and after sealing/abandonment of the reservoir?
   - Do the uncertainties justify considering an alternative accounting framework for emission reductions/removals from CCS project activities?
   - Who should be responsible (and liable) for any necessary remediation measures after well closure and/or after the end of the crediting period?
   - How can it be ensured that necessary remediation measures are undertaken?
   - What is the interaction with national regulation on these issues (many countries with underground or offshore operations have mining laws that regulate site abandonment and long-term liability)?

For the small scale submission (SSC_038), the issue of permanence is phrased in terms of precipitation of calcium carbonate from solution, releasing CO_2. The submitted methodology does not address this in a way that allows quantification to account for the seepage.

2.3. Project boundary

8. The following issues relating to the project boundary and partially relevant to NM0167 and NM0168 appear to go beyond current CDM procedures:

- Storage of CO_2 may take place in geological reservoirs offshore (international waters) or in the water column of the ocean (ocean storage). In this case, it is not clear how seepage emissions would be reported in GHG inventories and which DNA would need to endorse the CDM project activity.
- Several projects may store CO_2 in the same reservoir. In such cases, several issues, such as the responsibility for any seepage emissions, for monitoring and for remediation measures, may need special attention.
- Gases may be stored in a reservoir in one country and migrate to another country.
- The extent of the storage area boundary requires a clearer definition. For example, should it include, in addition to the reservoir targeted for injection, secondary constraining reservoirs above the targeted storage reservoir to ensure that migration of CO_2 to other underground locations is detected? Although the methodologies NM0167 and NM0168 state that the whole storage reservoir is included in the project boundary, they do not clarify the exact spatial extent of the reservoir, and whether secondary sedimentary basins above the target reservoir are included.

Regarding the small-scale submission (SSC_038), it is noted that there might be difficulties in enforcing the project boundary for monitoring purposes due to the flow of the seawater and the bicarbonate solution. There may also be issues if the 20 km boundary crosses maritime boundaries of more than one country/party.

3. *Standard methodological issues in individual CCS methodology submissions*

This section addresses only those methodological issues that are comparable in nature to those faced by other proposed CDM methodologies.

3.1. Specific issues related to NM0167

1. **Baseline scenario identification.** A thorough framework for considering baseline scenarios is very important and is lacking in the proposed methodology. The baseline scenario analysis is therefore inadequate. A number of key baseline situations are not currently considered, and these could be very relevant in a number of situations. The dimensions that need to be considered include:
    - **a. Power plant or other large emission source construction and operation.** The appropriate metric to estimate baseline emissions for CCS project activities is CO_2 avoided, not CO_2 captured. This methodology implicitly assumes that CO_2 captured is equal to CO_2 avoided. However, this is not necessarily true in all cases to which this methodology is applied, and in particular where the source facility is a power plant. The methodology should also explore whether actions at the source facility might otherwise occur that would reduce CO_2 emissions (e.g. improving combustion efficiency; waste gas/heat recovery), and which might not occur due to the project.
    - **b. Hydrocarbon (oil) production and fate of the storage site.** CO_2 injection is well known to be used to enhance hydrocarbon recovery (i.e. OER). In its absence (i.e. the baseline), there are many possibilities – for example reduced oil production and other

recovery techniques such as water flooding, which would have implications for emissions. These issues need to be addressed.

c. **Availability of alternative CO_2 sources for EOR, including both anthropogenic and natural sources.** Finally, though CO_2-EOR is not yet widely practiced outside North America, at high fossil fuel prices it might conceivably be or soon become a common practice in some NAI regions. Thus, a baseline scenario might also be enhanced oil recovery using natural CO_2 sources. While currently unlikely in many situations, this should be considered as a possible baseline scenario when applying the methodology.

The most likely baseline scenario should be identified independently for each of the above three dimensions.

2. **Baseline scenario/additionality.** Guidance on how to assess additionality (and/or select the most likely baseline scenario) is required for Enhanced Oil Recovery project activities . It might be useful to delineate in which cases the barrier and the investment analysis should be applied, e.g. the barrier analysis may be more relevant in early stages of CCS development, when technology is less mature, experience is lacking and risks are very high. Conversely, if CCS for EOR becomes an established technology, investment analysis may become more relevant. With respect to investment analysis, guidance may be required on how to assess prospective oil prices. In this regard there are currently inconsistencies between the baseline scenario and additionality sections in the CDM-NMB, which may need to be rectified.
3. **Project Boundary (CO_2 source).** For several reasons, the CO_2 source facility should be included in the project boundary, as it is the source of emissions that are reduced. If under the baseline situation the source facility would otherwise cease operation, then there would be no emissions to reduce. This may be an unlikely situation for NM0167; however, it would appear unjustified to exclude the plant from the project boundary. The inclusion of the CO_2 source facility within the boundary becomes especially relevant if technologies other than post-combustion capture are utilized. It is also important for consistency with baseline scenario assessment as described in the first point above.
4. **Project emissions.** The source / emission factor for electricity used for carbon capture purposes and the mass balance approach to project emissions needs to be revisited.
5. **Leakage.** This section of the methodology fails to discuss a key potential source of leakage – i.e. impacts of increased oil production due to EOR on oil markets and any increase in overall oil use emissions. Without pre-judging whether these increases are significant or necessarily need to be quantified/considered, a cogent rationale must be provided if they are excluded from leakage, along with the means to ensure that this exclusion is justified depending upon project circumstances.
6. **Monitoring.** NM0167 does not provide a complete monitoring methodology, and is thus difficult to review in detail. However, some suggestions can be made:
   a. There are many potential monitoring techniques that can improve the accuracy of the monitoring plan, not all of which are considered.
   b. There should also be monitoring of both CH_4 in the soil gas, and impurities in the injection CO_2.
   c. The monitoring techniques should be based on the potential seepage routes. A geological survey of the reservoir, mapping those potential routes, should therefore be carried out before the monitoring techniques are determined.
   d. More detail on the monitoring techniques should be provided.
   e. The monitoring techniques should be argued to be appropriate for the benchmark seepage rates.

f. The methodology does not address the possibility of mobilisation of methane in hydrocarbon reservoirs due to increased pressure.
g. The use of the mass balance approach may be appropriate.

3.2. Specific issues related to NM0168

1. **Impurity of gas.** The proposed new methodology intends to inject acid gas containing CO_2. This is different from a pure CO_2 stream. Even small impurities change the chemical and physical behaviour of a fluid (here the CO_2 / acid gas stream) including its possible reactivity with reservoir and cap rocks. The IPCC SRCCS points out that impurities affect the level of risk, especially if sulphur is involved. Most models and simulations are performed assuming pure CO_2. Impurities are difficult to deal with and thermodynamic data for complex mixtures are not available at present. More detailed information on how the proposed methodology intends to address the additional risks related to the impurities in the gas should be provided. The possibility to store a pure CO_2 stream should be reconsidered.
2. **Baseline selection procedure.** The methodology suggests a good procedure for the identification of plausible baseline scenarios options. However, guidance on how to select the most plausible scenario is not specific enough and needs further elaboration.
3. **Investment analysis of additionality test.** The methodology states, "There are no economic benefits other than CDM related income". In contrast, the baseline might include an acid gas incinerator and fuel use for its operation that will not be needed in the CCS project activity. A more comprehensive and sound method to conduct a financial analysis taking into consideration all relevant parameters is in needed here.
4. **Unclear applicability condition.** The condition regarding host country regulations needs to be specified.
5. **Unclear situation if storage is located in international waters.** The methodology should clarify which host country/DNA is responsible for projects located outside of national territories in international waters. Alternatively, projects in international waters could be excluded by introducing an applicability conditions.
6. **Monitoring.** Monitoring methodologies for CCS projects generally pose many issues that go beyond the usual monitoring issues for CDM projects, especially given the emerging nature of this field. There are also some fundamental dilemmas given the methodology’s dependence on accurate determination of seepage, which may not be achievable, and the lack of post-project monitoring.

   In particular, the monitoring of seepage would require further improvement. Desk reviews have made several suggestions to improve the monitoring (without being definite on whether these additions to the monitoring plan would lead to **real** and **measurable** emission reductions):
   a. A method for reconciling 3D seismic monitoring and geological simulation should be specified clearly;
   b. More frequent 3D seismic to allow for better future simulation could be performed;
   c. Soil gas and bottom water measurements could be performed periodically;
   d. For offshore sites, side-scan sonar, CO_2 buoy network in monitoring area, seabed monitoring under stable seabed conditions and bubble monitoring may be used to complement 3D seismic survey;
   e. For onshore sites, soil monitoring and sniffing may be employed;

f. If remote sensing by aircraft or satellite prove workable techniques, they may also be added where appropriate.

3.3. Specific issues related to SSC_038

Significant methodological concerns and challenges concerning permanence, leakage and boundary issues for project activities using this technology. The following issues were noted specifically with respect to small-scale submission SSC_038:

1. **Technological maturity**: Project activities to be considered under CDM should use technology that is proven under field conditions, as the CDM should not be used for demonstrating laboratory scale-technologies. It may be noted that considerable amount of effort by the Board its panel and working groups may be required to address the methodological issues of these unproven technologies without significant immediate potential;
2. **Project boundary**: There may be difficulties in enforcing the project boundary for monitoring purposes due to the flow of the seawater and the bicarbonate solution;
3. **Leakage**: Apart from the leakage identified (the additional use of electricity to keep the flow of sea water constant around the limestone basket), other leakage issues were identified, namely: a) emissions associated with the mining of calcium carbonate; and b) emissions associated with the transport of calcium carbonate; and c) release of CO_2 during the use of the bi-carbonate by marine organisms;
4. **Environmental impacts**: The environmental impacts of the project activity may need to be investigated and considered. Notably, the impacts of increased alkalinity and impurities such as NO_x and SO_2 in the flue gases on marine life such that an Environmental Impact Assessment is required.

4. Conclusions

The Methodology Panel of the CDM Executive Board has taken into consideration three proposed new methodologies for CCS project activities as CDM projects (NM0167, NM0168 and SSC_038) and identified a number of general methodological and accounting issues for such project activities under the CDM.

The approaches and procedures suggested by the submitted methodologies do not address the methodological and accounting issues in an appropriate and adequate fashion. This would therefore pose considerable difficulties in approving these proposed methodologies as CDM methodologies in their current form. In addition, it is questionable whether some issues can be resolved without further guidance from COP/MOP and/or a technical body on CCS.