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## **Sustainable Development (SD) appraisal of Clean Development Mechanism (CDM) projects – experiences from the SouthSouthNorth (SSN) project**

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### **ABSTRACT**

The Clean Development Mechanism (CDM), set up in the Kyoto Protocol (KP), is an original tool in the international arena, designed to deal with the world-wide problem of reducing Greenhouse Gasses (GHGs) which are harmful to the world's climate system. Developed countries are asked to commit themselves voluntarily to meeting targets of emissions reduction. At the same time, a free market is created to transact these reduction units, encouraging investment in developing countries and technology transfers. The big proviso to such investment is that it must contribute to Sustainable Development (SD) in the country where the investment takes place.

It is argued that SD is an important requirement of the KP, helps to maintain environmental integrity and should be rigorously assessed prior to any investment in a CDM project. The benefits of this would be certainty in the application of the CDM, reduction of risk to investors, developers and owners and the provision of cost-free assistance to developing countries that could reduce the enormous divide between countries of the North and those of the South.

The SSN project<sup>1</sup>, an experiment in southern led CDM project development, has proposed a methodology for appraising the suitability of candidate CDM projects. This methodology involves the use of criteria for assessing eligibility in the first instance, as well as a set of quantifiable indicators for use as a check-list against which project developers can evaluate projects, not least in terms of its contribution to SD. This methodology includes an incremental approach to ensuring that projects are assessed rigorously, by proposing a list of indicators that must be satisfied before projects are likely to be given formal approval by the DNA. The SSN project proposes this methodology as one way to reduce the risks involved in the high costs of transacting CDM projects. At the same time, the methodology promotes the preservation of environmental integrity/sustainability.

This paper presents this criteria and indicators appraisal tool, on the basis of actual experience of applying it in practice, and proposes that the institutional structures in countries of the south would also benefit from using the tool. It is proposed that this methodology would help to harness the considerable potential for countries of the South to attract additional investment in clean and sustainable development through the climate window.

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### **1 INTRODUCTION: CDM AND THE SSN**

The paper considers the potential for Clean Development Mechanism (CDM) projects to contribute to sustainable development. The SouthSouthNorth project, an initiative based in Bangladesh, Brazil, Indonesia and South Africa, emphasizes the sustainable development priorities of candidate CDM projects and

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suggests a methodology for the appraisal and rating of such projects, particularly regarding their likelihood of contributing to sustainable development. The value of such rigorous prior assessment of projects is seen as a way to limit the risks involved in the potentially high transaction costs of such projects. In this way, the CDM may become a viable tool for encouraging sustainable development assistance to developing countries that would otherwise be unlikely.

Consistent with this effort at promoting sustainable development, SSN further proposes a methodology of Development Facilitation (and training of CDM development facilitators) in order to safeguard the delivery of units without compromising the development of capacity in CDM projects.

## **2 BACKGROUND: THE KYOTO PROTOCOL AND THE CLEAN DEVELOPMENT MECHANISM**

### **United Nations Convention on Climate Change (UNFCCC)<sup>2</sup> and the Kyoto Protocol (KP)**

Under the UNFCCC, ratified by sufficient members of the UN, the Kyoto Protocol seeks to control anthropogenic (man-made) Greenhouse Gasses (GHGs) in order to stabilise the amount of those dangerous gasses in the atmosphere which tend to interfere with the world's climate system. While all countries are at risk from this, the Protocol seeks to differentiate in the responsibilities of nations by requiring only industrialised countries, at this stage, to reach targets by which they must reduce their emissions. Those countries which are still developing do not have to reach targets at this stage. Thus there is a so-called North-South divide. In the first place, countries of the North are responsible for three-quarters of all emissions from human activities, and in the second place, such countries are more likely to be able to afford the costs of reducing emissions without compromising their ability to sustain development in economic terms.

Under the Kyoto Protocol, Northern countries, the countries listed in Annexure 1 to the Protocol, must reduce their emissions by 5 % compared to 1990 levels by the period 2008-2012. The Protocol recognises that the cost of doing so could be enormous, and so to encourage compliance has introduced several market-based mechanisms. This paper deals only with one of these mechanisms – the CDM.

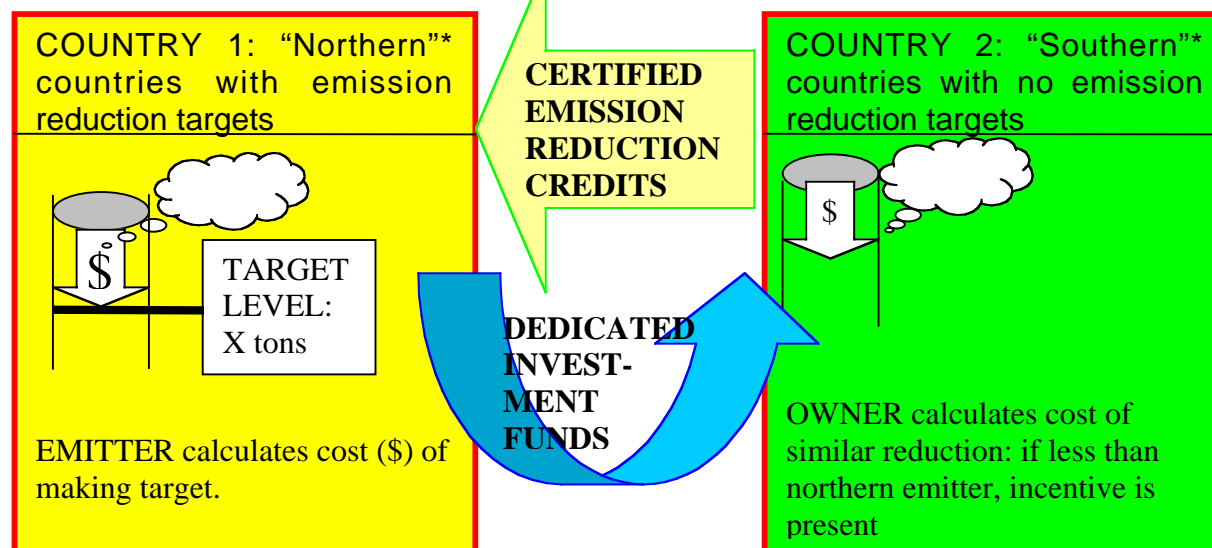
### **The CDM**

How the CDM works is that a polluter nation (obliged to reduce its emissions in order to meet its targets) can rely on a project that takes place in a developing country (that has no target to reach) and claim the credit from doing so. It would usually be cheaper to invest in the reduction of emissions in developing countries than by domestic action in industrialised countries. This process envisages the value of technology in reducing emissions, the value to the developing country of cleaner and newer technology and the use of market forces to keep the costs of reducing emissions down. Coupled with enforceable targets, this should create a lively and productive market in Carbon Reduction Credits, or Certified Emissions Reductions (CERs) units. This involves the original idea of using global governance negotiated in the final Kyoto Protocol texts along with market forces to reduce GHGs, which after all, is a world-wide problem, while at the same time avoiding mere control and command to enforce compliance. Since markets are inclined to find the least cost alternatives, the market could take off and spiral the costs of emissions reductions downwards.

The Kyoto Protocol lays down the mechanics of the workings of the CDM. In the first instance, host countries where a project takes place must establish a Designated National Authority (DNA) to approve projects. They may do so on the basis that a project complies with various requirements, including contributing to Sustainable Development in the host country. This is left to the host country to determine as a sovereign issue. There are also various public participation elements that will ensure local and international scrutiny of the project design document and the reports of the operational entities that put the project forward to the CDM Executive Board (EB) prior to

approval. After a project has been approved on the basis that it will indeed reduce emissions as compared with a baseline of anticipated emissions that would have occurred without the project, the actual emissions must be validated and the EB (set up by the parties to the UNFCCC) will register the CERs.

In simple terms, a project will work as follow/:



\* Northern countries are Annex I countries in the industrialised world who have taken on commitments under the Kyoto Protocol; Southern or non-Annex 1 countries are those in the developing world which do not have quantified emission reduction commitments at this stage.

The principle is that all parties benefit from the CDM: the host country is assisted in achieving sustainable development, the owner of the CDM project receives a contribution to project finance and technological assistance, and the emitter receives emission reduction credits.

### 3 THE SOUTH SOUTH NORTH PROJECT

The relative lack of capacity and expertise within developing countries in dealing with CDM projects and related processes, such as the financial, public consultation, investment, negotiating, assessing and institutional aspects of CDM projects means that the whole mechanism itself is under threat. Whether investment in CDM projects will take place, and whether they will in fact contribute to host countries both financially and in terms of sustainability is an open question. The **SouthSouthNorth** Project, SSN for short, is one initiative aimed at developing confidence in developing country agencies in the public and private sphere to deal effectively with the CDM. A uniquely southern-based drive, SSN is a non-profit NGO, designed to experiment in learning by doing to help ensure the best possible practice in the countries in which it is based, in managing all aspects of CDM. This includes everything to do with CDM projects and capability, including the all-important requirement of defining and protecting sustainable development. It is anticipated that this will help to avoid a race to the bottom to undermine the sustainable development requirement which some see as a potential barrier to project investment.

#### Why does SSN exist?

The CDM offers an opportunity to promote sustainable development and to direct the flow of capital, expertise and technology into developing economies through the climate window. Brazil, South Africa, Bangladesh and Indonesia face similar challenges in getting ready to seize these initiatives and to make them

project cycle for host governments, the wider public, CDM project owners, their technical intermediaries and project beneficiaries. At the same time, SSN can help decision-makers and their agents to handle applications for CDM scheme approval with objectivity while seeking to promote southern benefits. SSN fosters capacity by providing training on the project cycle, development facilitation and other information, as well as by forging links between the countries in which it operates.

### **Why the name "SSN"?**

It is important that stakeholders in the South are able to identify suitable CDM projects, build their own skills base, manage their own risks, foster the transfer of technologies and be ready to approach Northern investors on their own terms with which they may wish to transact projects. This is crucial because Northern stakeholders are unlikely to take the initiative on behalf of Southern countries and will not invest in countries that do not have the formal readiness to approve projects. The development of robust rules and the capacity to employ them will ensure environmental integrity and create appraisal certainty, reduce risks, potentially minimize transaction costs and promote sustainable development.

## **4 PROJECT APPRAISEL: EVOLVING METHODOLOGI FOR APPLYING CRITERIA AND INDICATORS AND ESTABLISHING BASELINES**

There appear to be general understandings of what constitutes an unsustainable development, but the question of how to measure projects' contributions to sustainable development needs to be defined. The meagre definition of CDM in the Kyoto Protocol of August 1997 prompted a period dedicated to addressing the question of what constitutes a contribution to sustainable development. SSN's policy researchers and scientists, Steve Thorne and Emilio La Rovere, prepared a paper, *Criteria and Indicators for Appraising Clean Development Mechanism Projects*<sup>3</sup>, which was presented by Helio International at COP 5 in November 1999. It presents a comprehensive set of Criteria and Indicators to assess CDM projects' eligibility and feasibility that is capable of rating them for feasibility and for their contributions to sustainable development.

This methodology could be helpful to every stakeholder in the CDM, both on the side of the developer of a scheme and on the side of Government who would need to evaluate, approve and/or reject CDM projects before they proceed with detailed design and, ultimately, registration.

Beginning in August 2000, in-depth country studies were undertaken to assess local opportunities for proceeding (a top-down approach). In the second place, a process of development facilitation was used to scope potential stakeholders and find potential projects (a bottom up approach). This process entailed formal and informal communications with parties involved in activities that had varying degrees of climatic impact in each country. SSN teams interviewed key stakeholders in the relevant sectors. This included government departments and ministries that deal with matters of trade, transport, energy and environment (climate change). Also included were local government's environmental management and their providers of services. In addition, private sector agencies in high energy consuming industries (often correlating with high possibilities for reducing energy and hence emissions) were included in this interviewing process.

### **The SSN sustainable development tool**

Projects would first be excluded if they were not eligible. The eligibility tests include measurability of emissions reductions, energy projects only (no sinks), sustainable development (minimum positive contribution to global and local environment) and four additionality tests. Additionality refers to a series of tests to ensure that the project would not have happened anyway. They include tests of financial, investment, environmental and technological additionality. The eligibility tests have "yes" or "no" answers. The additionality tests require the development of scenarios describing what would have happened in the absence of the project or a baseline – the development of which is an evolving science in itself. At the time of

developing SSN the rating matrix, the definitions of what additionality is was considerably more stringent (particularly the issue of investment additionality). The SSN team applied these more stringent definitions in assessing eligibility of projects. A number of project concepts were dropped when the SSN team imposed an eligibility test of transparency. Projects were excluded where project owners (or their brokers) insisted on confidentiality that would limit the capacity building objectives of the SSN experience. Once projects have passed the eligibility tests, the project is appraised using sustainable development indicators. These indicators do not provide “yes” or “no” answers as the eligibility tests do, but rather a rating of how the project score against the particular index. The appraisal provides a rating between –3 and +3, with +3 being a very positive contribution, 0 being no change in the index, and –3 very negative. The first pass of the project appraisal is, with a few exceptions, qualitative. The same ratings are applied to the feasibility criteria. These criteria were devised without any reference to the negotiation text and were purely to provide indications of feasibility for the SSN team and project owners, and in some instances indications of eligibility<sup>4</sup>.

SSN has used this rating matrix tool to appraise and rank a variety of projects in each of the countries of its operation to test the appraisal tool against actual projects. SSN has accordingly insisted on full transparency for the greatest possible sharing of its learning in this process, sharing all reports on their open website.

The different country teams used the rating tool differently. In South Africa owners were asked to rate their own projects, in Indonesia the team weighted the sustainable development indices differently to the feasibility criteria and in Brazil issues such as success in the policy environment had little meaning as the policy environment is so enabling already.

The criteria and indicators with their current definitions are included below in full, and an example of the application of this methodology to one project example in Brazil is included in the annex:

**Table 1 The Criteria and Indicators appraisal matrix**

<b>Eligibility Criteria</b>	<b>Rating</b>	<b>Assessment</b>
1. Energy project activities qualifying for the CDM	Y/N	It is proposed that CDM projects in the energy sector be confined to those that employ technologies and techniques which contribute to: <ul style="list-style-type: none"> <li>• End-use energy efficiency (leading to real energy conservation).</li> <li>• Supply side energy efficiency in newly constructed facilities (such as co-generation).</li> <li>• Renewable energy to supply energy services.</li> <li>• The reduction of methane emissions from landfills and other waste-handling activities.</li> </ul> The reduction of N <sub>2</sub> O emissions from chemical industries and PFC emissions from aluminum production.
2. Real and measurable benefits	Y/N	Only projects in which emissions are measurable should qualify for CDM.
2A. Positive contribution to Sustainable Development	Y/N	Environmental and social sustainable development indicators must all be positive.
2B. Owner allows	Y/N	Owners or their agents must allow transparency in their project development

<sup>4</sup> In the case of project ownership, a project is most unlikely to succeed if there is not enthusiastic ownership of the

adequate transparency		for the sake of broad base capacity building.
<i>Additionality Filters</i>		
3. Environmental additionality	Y/N	Emissions are reduced below those that would have occurred in the absence of the registered CDM project activity.
4. Financial additionality	Y/N	[[Public] funding for [the acquisition of CERs resulting from] CDM project activities from Parties included in Annex I shall [be clearly additional to][and][not result in a diversion of [be separate from and shall not be counted towards] the financial obligations of Parties included in Annex II to the Convention within the framework of the financial mechanism as well as to [current] official development assistance (ODA) [flows]]
5. Investment additionality	Y/N	This criterion can apply to interventions in business-as-usual projects that show both environmental and financial additionality. In order have been implemented anyway, according to a realistic baseline. To receive CERs, CDM projects must be truly additional to those that would have happened anyway
6. Technological Additionality	Y/N	To be eligible as a CDM project activity, a proposed project activity must achieve a level of performance with respect to reductions in anthropogenic emissions by sources that is significantly better than average compared with recently undertaken and comparable activities or facilities within an appropriate geographical area.
<b>Sustainability Indicators</b>		
7. Indicator 1 – Contribution to the mitigation of Global Climate Change	-3 to +3	<p>Global environmental benefits will be measured by the net reduction of GHG emissions measured in CO<sub>2</sub> equivalent according to the IPCC GWP for a one hundred-year horizon.</p> <p>Vector:      0 = No change in GHG emission level compared with the baseline.                         3+ = Total avoidance of the GHG emissions predicted.</p> <p>The main difficulty with quantifying this indicator is estimating the leakage (see below). Complete leakage accounting is required within the host country and sometimes abroad, for example, in cases where domestic fuels switching results in take back in a range of energy services. For example photovoltaic lighting replaces kerosene for lighting which then provides additional kerosene for cooking.</p>
8. Indicator 2 – Contribution to local environmental sustainability	-3 to +3	<p>Local environmental impacts will be assessed by the percentage change in the emissions of the most significant local pollutant (oxides of sulphur, nitrogen, carbon and other atmospheric wastes; radioactive waste, VOC, TSP or any solid or liquid waste). A weighted average percentage change may be used when more than one pollutant is considered to be relevant.</p> <p>Vector: 0 = No change in emission level of the selected pollutant.                 3+ = Total avoidance of emissions of the local pollutant.                 3- = Emissions of the local pollutant are doubled.</p> <p>Subjectivity is an unavoidable weakness of this indicator, given the necessary selection of sample pollutants for monitoring.</p>
9. Indicator 3 – Contribution to net employment generation	-3 to +3	<p>Net employment generation will be taken as an indicator of social sustainability, measured by the number of additional jobs created by the CDM project in comparison with the baseline.</p> <p>Vector: 0 = No change in employment level compared with baseline.                 +3 = Doubled number of jobs.</p>

		<p>-3 = Elimination of all jobs predicted in the baseline.</p> <p>This indicator is problematic in that it doesn't register a qualitative value for employment, such as whether the resultant jobs are highly or poorly qualified, temporary or permanent, secure or 'flexible'. Figures are also subject to inflation depending on whether direct and indirect jobs are counted.</p>
10. Indicator 4 – Contribution to the sustainability of the balance of payments	-3 to +3	<p>Net foreign currency savings may result through a reduction of, for example, fossil fuel imports as a result of CDM projects. Any impact this has on the balance of payments of the recipient country may be compared with the baseline.</p> <p>Vector:        0 = No change in foreign currency expenditure compared with baseline.                          +3 = Total avoidance of foreign currency expenditures.                          -3 = Doubled net foreign currency expenditures.</p> <p>A major difficulty here is that estimates of future prices of imported goods and services replaced by the project can be quite uncertain (e.g. international oil prices).</p>
11. Indicator 5 – Contribution to macroeconomic Sustainability	-3 to +3	<p>The alleviation of the burden on public savings will be measured by the reduction of direct government (national, provincial and local) investments (including budgets of state enterprises) made possible by the foreign private investment in the CDM project in comparison with the baseline.</p> <p>Vector:        0 = No change in public investments compared to the baseline.                          +3 = Total avoidance of public investments.</p> <p>The challenge here is to calculate the saving of public financial resources net of subsidies and to ascertain the additionality of the foreign private investment</p>
12. Indicator 6 – Cost Effectiveness	-3 to +3	<p>Cost reductions implied by the CDM project in comparison with the baseline will measure the contribution to increased microeconomic sustainability. The value of this indicator will only be positive in the case of "win-win" ("no-regrets") projects.</p> <p>sensitivity of the results to these key assumptions.</p> <p>Vector:        0 = No change in costs compared to the baseline.                          +3 = Total avoidance of costs compared to the baseline.                          -3 = Doubled costs compared to baseline.</p>
13. Indicator 7 – Contribution to technological self-reliance	-3 to +3	<p>As the amount of expenditure on technology changes between the host and foreign investors, a decrease of foreign currency investment may indicate an increase of technological sustainability. When CDM projects lead to a reduction of foreign expenditure via a greater contribution of domestically produced equipment, royalty payments and license fees, imported technical assistance should decrease in comparison with the baseline.</p> <p>Vector:        3 = No change in foreign currency expenditures with technology compared to the baseline.                          +3 = Total avoidance of foreign currency expenditures.                          -3 = Doubled foreign currency expenditures with technology.</p> <p>Data collection on full technology costs can be difficult in some cases.</p>

14. Indicator 8 – Contribution to the sustainable use of natural resources	-3 to +3	<p>CDM projects should lead to a reduction in the depletion of non-renewable natural resources either through the adoption of technologies with higher energy efficiency or through an increased deployment of renewable resources, such as the replacement of fossil fuels with solar or wind energy.</p> <p>In both cases, CDM projects will contribute to a more sustainable use of natural resources.</p> <p>Vector:      0 = No change in non-renewable natural resource use.                         +3 = Avoidance of all non-renewable natural resources.                         -3 = Doubled use of non-renewable natural resources.</p> <p>Uncertainty regarding the performance of technological innovations must be accounted for. Again, two well-contrasted project performances can be used to provide a sensitivity analysis.</p>
<b>Subtotal</b>		Depending upon National/Local policy, this sub-total can be weighted (depending on the bias required towards SD requirements) against the Sustainable Development indicators.
<b>Feasibility Indicators</b>		
15. Maximisation of project owner and Southern country benefits	-3 to +3	The benefits to the project investor, owner, and other local and regional stakeholders can be assessed to establish what these could be. If the benefits are limited to the technology and climate mitigation alone the project scores low, however should the project host country also gain economic, social and/or environmental benefits including the sharing CERs and other win-win benefits with project stakeholders and the broader community, the project scores high.
16. Possibilities of South South axis of technology and information transfer	-3 to +3	A desirable outcome of the SSN project is to improve the Southern axis of trade and innovation. Therefore projects that involve a high component of technologies that can be sourced in the south will score high. Projects that have minimum contributions of southern sourced technologies will score low on this criterion.
17. Chances of success in current policy and institutional environment	-3 to +3	The chances of success are a function of a number of parameters; here we are considering the policy and institutional environment of the host country. Is the project intervention in keeping with national energy/environment/trade etc. policy? Is it backed up by the institutions in government? If the answer is yes to both, the project scores high on this criterion. Conversely, if there outright rejection in policy or by the institutions managing the project, it will score low. Policy appreciation of the project ideas without the backing of institutions can be ranked as neutral. Conflict with national policy can be considered a fatal barrier to the project's consideration and the project should be dropped.
18. Barriers to implementation (no fatal barriers)	-3 to +3	An assessment of the size of technical, financial, institutional, human capacity and/or awareness barriers may provide a range of impediments that can vary in significance. Barriers that are entirely overcome by the CDM project score high, whereas projects that are impeded by barriers would score low. Any barriers that are considered to be fatal are to be presented in the introduction to the individual projects, and the project should then be excluded.
19. Possibilities for regional integration	-3 to +3	Consideration is given to the projects' ability to contribute to regional (within a country or sub-continently) economic integration. The stronger the projects' contribution to regional integration, the higher the score. Should the project have no direct or indirect impacts on regional integration, the project will get a low score for this criterion.

20. Project owners willingness to champion the project	-3 to +3	The project will not go ahead without the support and commitment of the project owner. In fact projects could go very slowly unless owners are willing to lobby powerfully the institutions that could drag their feet or become “gatekeepers” for CDM projects. Strong commitment to own the project will score high whereas if the project does not have an immediate and existing owner the project will score low. Projects where the owners show limited interest should be dropped.
21. The ability of project owner to influence national political will and General capacity of project owner	-3 to +3	In the first batch of CDM projects institutional barriers will undoubtedly present the largest barriers to the candidate projects. This criterion assesses the ability of the project owner to influence the political will of government in the streamlining of the CDM project cycle. So small NGO projects would score low while large parastatals/corporates would score high.
22. Possibility of leakage	-3 to +3	Leakage inside and outside, upstream and downstream of the project boundary must be identified. In the case of land-use change, projects should be scrutinized from a regional perspective to measure cross-border leakages. If this likely to be high as in the case of the introduction of technologies with high energy intensities in the manufacturing, transportation to the point of use, installation, maintenance, disposal or recycling, the project will score low or negative points. Projects that have no or low levels of leakage will score high on the points scale.
23. Sectoral spread household/municipal/commercial/industry spread	-3 to +3	If the project is the only candidate in the sector, it scores high. If it is one of many it scores low - as do all the other candidate projects in the same sector. Sectors include, but are not limited to: bulk energy, stand-alone energy, industry, mining, commercial, household/ municipal, transport, agriculture and fishing, and so on.
24. Local/regional replicability	-3 to +3	If a successfully implemented project could easily be replicated in other regions within the same country (as domestic action), or regionally (sub-continently) as another CDM project, this is desirable and would warrant a high score.
<b>Subtotal</b>		Depending upon National/Local policy, this sub-total can be weighted against the Sustainable Development indicators.
<b>TOTAL</b>		Addition of all the individual qualitative assessments provides the number which when compared with other project scores can be used to attain a final ranking. Any failure to pass the eligibility criteria, additionality filters, negative scores on the social and/or environmental sustainable development criteria or other fatal barriers detected in the assessment will provide grounds for the exclusion of the project. In undertaking conservative assessments of the candidate projects, any high risks of project qualification or strong possibilities for unsuccessful implementation, would provide sufficient grounds for project exclusion at this stage.

The composite rating of the projects allowed the projects to be ranked. In Bangladesh and Indonesia 4 projects were rated and ranked, in South Africa 5 and in Brazil some 18. These projects were presented to a full SSN team meeting in Jakarta in May 2001 and together the countries teams reviewed each other's assessments and advised final selections of the top 2 per country and one contingency per country<sup>5</sup>.

The application of the above test differed slightly in the four countries concerned. The selected projects in each country are now in the process of being developed. The candidate pilot projects are in urban bus efficiency, geothermal electricity generation, small electric vehicles, solar home systems, landfill gas

<sup>5</sup> The full results of this process can be downloaded in the country reports for Phase 2 of the SSN Project at [www.southsouthnorth.org](http://www.southsouthnorth.org)

electricity generation, improved efficiency in urban and rural low cost housing, industrial energy efficiency in the paper industry, biodiesel production from vegetable oils, and bio-digestion for power generation. The SSN project will cover the majority of costs and facilitate the management of taking each of these projects to the point of transaction. During the process of project development, the indicators will be revisited with the intention of improving the qualitative characteristics of the criteria and indicators. The SSN team sees this as an incremental approach until the appraisal tool becomes sufficiently robust to be considered objective in its measurement if not its methodology.

The final step in assuring sustainable development will be to tie the indices into the monitoring protocols of the projects during their implementation. The SSN project will also cover the costs of monitoring of project preparation and the development of project specific monitoring protocols and of SSN's technical work in this regard, to ensure that rigorous standards and reliable results are achieved. Such measures should ensure compliance with the sustainable development principle beyond project appraisal and be a valuable source of information in refining this decision making tool.

## **5 TOWARDS A DEFINITION OF SUSTAINABLE DEVELOPMENT: SSN'S EXPERIENCE**

Development, it is believed, means broadly that units of development (plant, investment, technology, jobs and so forth) are contributed via investment to a beneficiary or set of beneficiaries. Under the CDM the return lies in the difference between the cost of compliance in the investing country and the cost of equivalent greenhouse gas reductions in the developing country. In addition to the application of the units of development, Sustainable Development, by contrast, is only promoted if the delivery of units is achieved in such a way that it is sustainable in social, economic, technological and environmental terms. But Sustainable Development is not served, it is submitted, by delivery of units alone.

In addition to the receipt of units of development (plant, investment, technology, jobs and so forth), it is maintained that Sustainable Development is only promoted if the delivery of units is achieved in such a way that it develops, to a degree that is significant, the capacity of beneficiaries to receive, manage and benefit from those units at levels which are meaningful in social, economic, technological and environmental terms. The measure of what is significant will always be subjectively determined, but involves issues of scale and time and, it is submitted, should be assessed in terms of intensity relative to the beneficiary. Thus Sustainable Development involves the delivery of units but only if there is equally a growth in capacity. In the context of the CDM, this is particularly pertinent when large numbers of beneficiary stakeholders are involved.

Aside from the assessment of a project's contribution to Sustainable Development in terms of the methodology applied in 4. above, the SSN Project approaches the design and implementation of projects through Development Facilitators who are trained specifically by SSN to design and manage projects at arms length from owners and investors with a view to ensuring the development of capacity and sustainability. This is designed to reduce the risk of projects being rejected for failing to comply with the KP.

The job of the Development Facilitators is monitored through SSN appointed monitors to further ensure that sustainable development is promoted by the project, at the project level. Such Development Facilitation is applied to the design and implementation of the pilot CDM projects in order to safeguard the delivery of units without compromising the development of capacity. In this way, the contribution of a project to sustainable development is ensured on a micro-level. The Designated National Authority, in appraising a project along similar criteria and indicators as those proposed in the SSN methodology in 4. above, will be ensuring sustainable development on a macro-level. In each case, the requirements of the Kyoto Protocol are complied with.

The experience of SSN was that while stakeholders were scoped in the four countries of operation, by using the C&I rating matrix outlined in 4. above, projects that scored highest were those projects which

contributed most highly to sustainable development. This has the advantage that such projects almost certainly will contribute to sustainable development at the stage of implementation reducing the element of risk inherent in any development project where there may be inconsistency between planning and implementation. Moreover, the high level of stakeholder involvement at the scoping stage has led to the evolution of projects where the degree of public involvement may be anticipated with a high degree of clarity. This may substantially contribute to the project's having favourable outcomes. Development Facilitators will be especially trained to manage the public participation elements of projects, which will reinforce the project's contribution to sustainable development.

The CDM is a uniquely public process in certain respects, and while the sole arbiter of the sustainable development proviso in the CDM definition is the host government, this decision has consequences within the public arena. This requires a swift analysis of the Marrakesh text:

Para 40(a) states that the DESIGNATED OPERATIONAL ENTITY shall:

*“Prior to the submission of the validation report to the executive board, have received from the project participants written approval of voluntary participation from the DESIGNATED NATIONAL AUTHORITY of each party involved, including confirmation by the host Party that the project activity assists it in achieving sustainable development.”*

How will the Designated National Authority fulfil its role of approving projects? The draft proposals, pre-Marrakech, gave the national authority in the host country some guidance, the text then stating: “Sustainable Development priorities must be based on the best available long-term environmental option, taking into account local and national needs and priorities. Technology transfer shall be state-of-the-art and environmentally sound; and priority should be given to renewable energy, energy efficiency”, and so forth. These general guidelines fell away in the final text. During the negotiations some parties expressed considerable concern that by defining what constitutes sustainable development and by limiting the choice of technologies the sovereignty of parties would be undermined. This argument prevailed and there is no reference to what kind of technologies would be considered sustainable other than in the definition of the small-scale or prompt start CDM projects and in the exclusion of nuclear technology.

The COP and the EB seem to have essentially absorbed the SD objective of the CDM into one simple declaration: "...it is the host Party's prerogative to confirm whether a clean development mechanism project activity assists it in achieving sustainable development" (Dec. 17/COP.7). None of the Monitoring, Verification, and Certification text even mentions observing or assessing the SD benefits of projects and focus entirely on the emissions impacts. As a result, there is not even a minimal standard for SD and nothing to prevent a "race to the bottom" among CDM host countries competing for investors. At present, the CDM is a buyer's market, and there seems to be nothing to prevent prospective projects with SD "frills" from simply being priced out of the market. This is a problem.

Clearly, without any explicit SD provisions, GHG-reducing projects might still generate some of those oft-cited co-benefits (more foreign investment, energy savings, local pollution reduction, etc.). But there are important questions to be asked before this can be taken at face value --- will these SD co-benefits be significant? Will they ever reach the majority that doesn't consume much fossil fuel? If the CDM doesn't come with provisions directly aimed at ensuring SD benefits, doesn't the market for CERs become indistinguishable from the market for any other internationally traded commodities ...textiles, copper, oil... where investment decisions are determined solely by cost-effectiveness and profitability factors and the SD benefits are relegated to some presumed macroeconomic trickle-down?

There are certain inclusions in the final text, whoever, which would give host government DNA's pause for thought before approving projects with little of no obvious SD benefits. These inclusions all relate to public participation, and the public nature of the CDM. The relevant text reads:

Prior to submission for validation the DESIGNATED OPERATIONAL ENTITY shall:

“37(b) (confirm that) Comments by local stakeholders have been invited, a summary of the comments received has been provided, and a report to the DESIGNATED OPERATIONAL ENTITY on how due account was taken of any comments has been received;

37(c) Project participants have submitted to the DESIGNATED OPERATIONAL ENTITY documentation on the analysis of the environmental impacts of the project activity, including transboundary impacts and, if those impacts are considered significant by the project participants or the Host party have undertaken and environmental impact assessment in accordance with procedures as required by the host Party.

40(b) ...make publicly available the project design document;

40(c) receive within 30 days comments on the validation requirements from Parties, stakeholders and the UNFCCC accredited NGOs and make them publicly available; ...”

There is the 30 day window for stakeholders and UNFCCC accredited NGOs to provide comments that will be taken into account in validating projects. It is very difficult to tell how powerful this will be as a lever for influencing projects. Paragraph 40(c) provides that the Operational Entity must "receive comments on validation requirements". One of the validation requirements is comments from local stakeholders contained in Para 37 (b). If these object that the project has not contributed to SD and such objections are not dealt with by the developer to meet the requirement ("how due account was taken etc"), then an international stakeholder (under 40(c)) could comment. The effort will of course be to force a review under 41(a).

SSN makes the submission that risk of cardinal importance to the DNA: approval on flimsy grounds raises the risk of a challenge under the scrutiny clauses; whereas the application of objectively determined SD indicators to the project application goes a long way to minimizing that risk. This certainty is then passed on to the project participants.

In summary:

- The sustainable development filter is to be developed at a national level in assessing candidate CDM projects.
- Local and international participation in/and scrutiny of projects as stipulated in the Kyoto Protocol may enhance the integrity of Sustainable Development requirements.
- The DESIGNATED OPERATIONAL ENTITY is required to appraise the candidate CDM project documentation including public processes and how these have been dealt with, DESIGNATED NATIONAL AUTHORITY approval of projects, Environmental Impact Assessments etc. and make a judgement call on whether these have been adequately dealt with prior to project validation.

## 6 CONCLUSIONS

There are a few significant advantages that CDM project owners and host country governments can harness, provided they have the capacity to do so. These include the selection of projects, the selection of investors and the timing of transactions. In the future, owners may be able to use a label that endorses the project against a particularly rigorous set of process and project design content criteria that will ensure standards that enhance the value of their projects.

By appraising projects against a robust set of criteria and indicators, such as that being used by SSN:

- host countries can exclude those that are considered undesirable;
- transaction costs may be limited;
- investor exposure to risks are contained through consistent and level playing field appraisal;
- guidelines can develop for the benefit of developers and project facilitators;
- key indicators to be monitored throughout the project cycle can be highlighted.

To investors, and some project hosts, the inclusion of the sustainable development requirements for CDM projects are seen as additional complications that will increase the transaction costs of projects, chasing investors away. The desperate need for investment at almost any cost may result in a race to the bottom in terms of reducing barriers to investment including the sustainable development criteria. This is particularly so given that, especially during the first commitment period, it is likely that it will be a buyer's market for those investing in CDMs. This is because of the amount of Russian so-called "hot air"<sup>6</sup> that may be available on the market, the reduction of investment additionality and the exclusion of the USA. It remains unclear what targets will be set in the envisaged second commitment period which promises will make investment in CDMs more attractive. Whatever the investment potential, however, the KP does stipulate the sustainable development requirement, so that it cannot be ignored.

One thing that is certain, however, is that without the institutional framework to assess and approve projects, the CDM will be an empty shell. Moreover, without certainty in its operation, such institutional entities will be more destructive than productive, and seeing that the CDM is conditional upon various requirements, including the contribution to sustainable development, it seems essential that whatever structures are put in place in developing countries they would be well advised to adopt a policy of stringency. The example may be given that there is no shortage of investors in countries such as Singapore which have very stringent hurdles for investors to traverse, while in Uganda, where there are very few obstacles to investment, almost no international investment takes place. By using the SSN's C&I rating matrix, it is suggested that investors will be attracted because of the certainty that will be provided by a situation where there can be little risk for investors that their projects may not ultimately be verified and produce valuable CERs. The investments are also likely to have longer term benefits than those linked to current policy-makers' term of office.

The SSN Project has had some measure of influence already in suggesting the tests that the DNA in Brazil will follow. In Indonesia, SSN has influenced the setting up of a one-stop clearing house for CDM projects that will facilitate the approval of projects for investors/owners. In South Africa, SSN has been approached by Government to help to set up a CDM office and has raised its own funding to do so.

The SSN project is still in its early stages having identified, described, rated and selected projects in each of the 4 member countries. The Sustainable Development Indicators are still being assessed in a rather qualitative manner, but the indications are that the iterative approach to project design and the revisiting of the criteria and indicators through internal and external review will result in a robust tool that can be taken forward by monitors as projects are implemented. An outcome that provides capacity and advantage, in investment and SD terms, to Southern project hosts while maintaining environmental and transactional even-handedness or integrity in the process is anticipated.

## ANNEX 1 An example of the generation of power from Rice Husks

Eligibility Criteria	Rating	<i>Assessment</i>
1. Energy project activities qualifying for the CDM	Y	This Project uses a technique that helps boost the use of renewable sources of energy for cogeneration of 3 MW power and 15 tons/hour of low pressure steam, burning some 5 tons/hour of rice husks.
2. Real and measurable benefits	Y	Some 25% (*) of the electricity in Santa Catarina State is thermo-based, with the remainder coming from hydro sources. 25% of this plant output was thus assumed to avoid CO <sub>2</sub> emissions due to electricity generated from natural gas.
<i>Additionality Filters</i>		
3. Environmental additionality	Y	The power generation from natural gas baseline scenario

<sup>6</sup> The amount by which Russia has already, through economic recession, reduced its carbon emissions to negative levels

		posts CO2 emissions, while the alternative scenario for burning renewable biomass posts no emissions, according to the IPCC methodology.
4. Financial additionality	Y	The funding comes from a new source. There is no Official Development Assistance related to the project.
5. Investment additionality	?	The private investor has recently decided to start implementation of the project.
6. Technological Additionality	Y	Power generated from rice husks requires new technology to be used.
Sustainability Indicators		
7. Indicator 1 – Contribution to the mitigation of Global Climate Change	1	This Project helps reduce greenhouse gases emissions by some 1,770.00 tCO2 which means 35,400.00 over 20 years.
8. Indicator 2 – Contribution to local environmental sustainability	3	The Project makes a significant contribution to local environmental sustainability, because these agricultural wastes are harmful to human health, usually dumped on vacant plots of land. Additionally, there are no final disposal procedures for rice husks as a waste material, as they are generally burned in the open air. .
9. Indicator 3 – Contribution to net employment generation	0	Few new jobs are generated, as the only workers required are those operating the plant as the labor force for the rice plantations already exists. The alteration consists of the disposal system for this waste material.
10. Indicator 4 – Contribution to the sustainability of the balance of payments	-1	There are no significant differences in the use of imported materials due to this Project, as it uses a 15 ton/hour low pressure steam boiler linked to a condensation turbine running a Toshiba generator to produce electricity.
11. Indicator 5 – Contribution to macroeconomic Sustainability	0	The investment is being funded by private investors, as would be the natural gas-fired power plant in the baseline.
12. Indicator 6 – Cost Effectiveness	3	<p>Power generation costs through this technology are attractive at around US\$ 44.93 /MWh while it costs US\$ 36.18 /MWh using natural gas. Calculation of cost of tCO2 avoided: (US\$ -49.860 / year) / (1770 tCO2/year) = US\$ -28.17 / tCO2 (rate=10%) and (US\$ 84,755 /year) / (1770 t CO2/year) = US\$ 47.89 / tCO2 (rate=20%). The calculus comes bellow:</p> <p>Calculation of Total Cost of Rice Husk Power Plant/ MWh to generate around 15768 MWh/year</p> <p>1) Factors considered</p> <p>a) Lifetime: 20 years</p> <p>b) Capacity Factor: 60%</p> <p>c) Discount rate: 10%</p> <p>2) Data</p> <p>a) Total Investment – US\$2.500.000,00/3MW = US\$ 834/kW</p> <p>b) O &amp; M Cost = US\$ 12,00/MWh</p> <p>c) Fuel Cost = 0</p> <p>3) Calculation</p> <p>a) Annual Cost of Investment / MW</p> $\text{US\$ annual} = \text{Investment} \times \text{rate} \times (1+\text{rate})^n / ((1+\text{rate})^n - 1)$ $\text{US\$ annual} = \text{US\$}834/\text{kW} \times 0,1(1+0,1)^{20} / ((1+0,1)^{20} - 1) = \text{US\$}97,96/\text{kW} = \text{US\$} 97960,00/\text{MW}$ <p>b) Investment Cost/ MWh</p>

		<p> <math>8760\text{hs/year} \times 0,6 \text{ (F.C.=60\%)} = 5256 \text{ hs/year}</math>  <math>3\text{MW} \times 5256 = 15.768 \text{ MWh/year}</math>  <math>(\text{US}\\$97.960,00/\text{MW}) / 5256 \text{ hs} =</math>  <math>\text{US}\\$ 18,64/\text{MWh}</math>            c) Fuel Cost = zero (residue from rice)            d) Total Cost / MWh (discount rate=10%)            Total Cost = O&amp;M + Fuel + Investment            Total Cost = <math>\text{US}\\$12/\text{MWh} + \text{zero} + \text{US}\\$ 18,64/\text{MWh} =</math>  <math>\text{US}\\$30,64/\text{MWh} \text{ (rate=10\%)}</math>            OBS: <math>\text{US}\\$ 44,56 / \text{MWh}</math> (if rate = 20%)            Calculation of Total Cost of a Natural Gas Power Plant to            generate around 15.768 MWh  <math>(15.768 / 8760 \text{ hs} / 0,92 \text{ (capacity factor)}) = \text{around } 2\text{MW}.</math>            1) Factors considered            a) Lifetime: 20 years            b) Capacity Factor: 92%            c) Estimated Discount Rate: 10%            d) Efficiency = 45%            source: Schaeffer et alli, 2000            a) Total Investment – <math>\text{US}\\$495/\text{kW}</math>            b) O &amp; M Cost= <math>\text{US}\\$ 7,00/\text{MWh}</math>            c) Fuel Cost = <math>\text{US}\\$ 19,57/\text{t}</math>            2) Calculation (rate=10%)            a) Annual Cost of Investment / MW  <math>\text{US}\\$ \text{ annual} = \text{US}\\$495/\text{kW} \times \text{rate} (1+\text{rate})^n / ((1+\text{rate})^n - 1)</math>  <math>\text{US}\\$ \text{ annual} = \text{US}\\$495 / \text{kW} \times 0,1(1+0,1)^{20} / ((1+0,1)^{20} - 1)</math>  <math>\text{US}\\$ \text{ annual} = \text{US}\\$ 58,41 / \text{kW}</math>  <math>\text{US}\\$ \text{ annual} = \text{US}\\$58.410,00 / \text{MW}</math>            b) Annual Cost of Investment / MWh  <math>\text{hours / year} = 8760\text{hs}</math>  <math>8760 \times 0,92 \text{ (F.C.=92\%)} = 8059 \text{ hs/years}</math>  <math>2\text{MW} \times 8059 = 16.118 \text{ MWh/ano}</math>  <math>\text{US}\\$ \text{ annual/total hours in the year} = (\text{US}\\$58.410,00/\text{MW}) / 8059 \text{ hs} =</math>  <math>\text{US}\\$ 7,25/\text{MWh}</math>            c) Fuel costs per MWh  <math>\text{US}\\$19,57/\text{MWh}</math>            Fuel Cost Nat.Gas (NG) ( <math>\text{US}\\$/\text{MWh}</math> )=  <math>\text{US}\\$2,58/\text{Mbtu}</math> equivalent to <math>\text{US}\\$ 19,57/\text{MWh}</math> with            efficiency of plant=45%            Calculation: <math>(\text{US}\\$2,58/\text{Mbtu} \times 3,414\text{MBtu}/\text{MWh}) / 0,45 =</math>  <math>\text{US}\\$ 19,57/\text{MWh}</math>            d) Total Cost/ MWh (discount rate=10%)            Total Cost = O&amp;M + Fuel + Investment            Total Cost = <math>\text{US}\\$7/\text{MWh} + \text{US}\\$19,57/\text{MWh} + \text{US}\\$ 7,21/\text{MWh} = \text{US}\\$33,78/\text{MWh}</math>            OBS: If Discount Rate = 20%, Total Cost =  <math>\text{US}\\$ 39,18/\text{MWh}</math>            Calculation of Avoided Emissions:  <math>15768 \text{ MWh/year} \times 0,25 \times 0,449 \text{ tCO}_2/\text{MWh} = \text{around}</math>  <math>1770 \text{ tCO}_2/\text{year}</math>            Observ: 0,25 (25% of NG substitution)         </p>
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		<p>Summary of Calculation of Total Annual Cost and carbon avoided</p> <table border="1"> <thead> <tr> <th>10% Nat. Gas Plant</th> <th>20% NG Plant</th> <th>10% NG Plant</th> <th>20% NG Plant</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td>33,79x15.768 MWh/year</td> <td>39,18x15.768 MWh/year</td> </tr> <tr> <td>US\$33,79/MWh</td> <td>US\$39,18/MWh</td> <td>US\$ 532.725,00/y</td> <td>US\$ 617.851,71/y</td> </tr> <tr> <th>10% Rice husk Power Plant</th> <th>20% Rice husk Power Plant</th> <th>10% Rice husk Power Plant</th> <th>20% Rice husk Power Plant</th> </tr> <tr> <td></td> <td></td> <td>30,62x15.768 MWh/y</td> <td>44,56x15.768 MWh/year</td> </tr> <tr> <td>US\$30,62/MWh</td> <td>US\$44,56/MWh</td> <td>US\$ 482.865,06/y</td> <td>US\$ 702.607,33 /y</td> </tr> <tr> <th colspan="4">Alternative – Reference Scenario</th> </tr> <tr> <td></td> <td></td> <td>US\$ 482.865- US\$ 532.725</td> <td>US\$ 702.607,33/y- US\$ 617.851,71/y</td> </tr> <tr> <td>-3,16</td> <td>5,38</td> <td>-US\$ 49.860/y</td> <td>US\$ 84.755,62/y</td> </tr> </tbody> </table> <p>Calculation of cost of tCO2 avoided:  <math>(US\\$ -49.860 / \text{year}) / (1770 \text{ tCO}_2/\text{year}) = -US\ 28,17 / \text{tCO}_2 \text{ (rate=10\%)}</math>  <math>(US\\$ 84.755,62 / \text{year}) / (1770 \text{ t CO}_2/\text{year}) = US\\$ 47,89 / \text{tCO}_2 \text{ (rate=20\%);}</math>                      Compared to the sales price as the Regulatory Value established by Resolution 22 of 1th Feb 2001 issued by ANEEL for renewable energy resources, the IRR hovers at around 20%, while with natural guess it is 14%.</p>	10% Nat. Gas Plant	20% NG Plant	10% NG Plant	20% NG Plant			33,79x15.768 MWh/year	39,18x15.768 MWh/year	US\$33,79/MWh	US\$39,18/MWh	US\$ 532.725,00/y	US\$ 617.851,71/y	10% Rice husk Power Plant	20% Rice husk Power Plant	10% Rice husk Power Plant	20% Rice husk Power Plant			30,62x15.768 MWh/y	44,56x15.768 MWh/year	US\$30,62/MWh	US\$44,56/MWh	US\$ 482.865,06/y	US\$ 702.607,33 /y	Alternative – Reference Scenario						US\$ 482.865- US\$ 532.725	US\$ 702.607,33/y- US\$ 617.851,71/y	-3,16	5,38	-US\$ 49.860/y	US\$ 84.755,62/y
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-3,16	5,38	-US\$ 49.860/y	US\$ 84.755,62/y																																			
13. Indicator 7 – Contribution to technological self-reliance	3	Electricity generated from rice husks could encourage the production and marketing of Brazilian technology.																																				
14. Indicator 8 – Contribution to the sustainable use of natural resources	1	Rice husks are a renewable source of energy. Consequently, this Project could generate 15,768 MWh/year or (3MWx8760hsx60%), replacing natural gas which is a non-renewable energy source and fostering the sustainable use of natural resources.																																				
Subtotal	10																																					
Operationality Indicators																																						
15. Maximisation of project owner and Southern country benefits	2	As this is a Project requiring Brazilian investment capital, the risk of the CERs not benefiting Brazil is minor compared to projects depending on foreign capital.																																				
16. Possibilities of South South axis of technology and information transfer	3	There are ample possibilities of transferring power generation technology based on rice husks to countries whose economic development is based largely on rice plantations. Different qualities of rice crops have varying characteristics that modify the use of the husks as fuel. However, these differences are secondary. More specifically, many countries in Asia could well benefit from this type of technique, due to a significant rice production.																																				
17. Chances of success in current policy and institutional environment	3	In political and institutional terms, this Project could be rated as highly positive, as environmental non-governmental organizations and government entities have been voicing concern over the proper disposal of wastes from rice production.																																				

18. Barriers to implementation (no fatal barriers)	1	So far, this type of Project has been directed at self consumption of power despite some interest shown in retailing surplus electricity. Bringing contracts of this type into operation depends on agreements with local utilities, which should guarantee the purchase of the electricity produced, while rice-growers should guarantee supplies of the feedstock for a period of around three years.
19. Possibilities for regional integration	3	Regional integration should be enhanced at places where rice-growing is important. Portugal's power distribution utility (CGDe) has already developed thirteen power plants burning rice husks in Rio Grande do Sul State, producing a total of 110 MW. The possibilities of building other power plants fueled by rice husks and benefiting more than one farmer are quite promising. Another example of projects that could well be developed jointly with power generation and based on the same feedstock is the fabrication of rice husk silica to produce structural concrete, as indicated by a research project carried out by the University of São Carlos/ University of São Paulo.
20. Project owners willingness to champion the project	3	As an investor, the Urbano Agroindustrial company has shown interest in the idea of producing rice husk power plants for commercial purposes.
21. The ability of project owner to influence national political will and General capacity of project owner	2	At the moment, there is no Government support for this specific project, but ANEEL regulations already encourage biomass-fired power generation.
22. Possibility of leakage	3	There are no risks of leakage.
23. Sectoral spread household/municipal/commercial/ industry spread	3	This type of project sets an example under a policy of seeking solutions for the final disposal of solid wastes. Additionally, within a context of uncertainty in terms of power supplies in Brazil, power self-sufficiency is being sought in many sectors of the Brazilian economy, as are efforts at boosting productivity through a steady supply of uninterrupted electricity.
24. Local/regional replicability	3	There is potential for local and regional replicability through groups of rice-growers or under agreements with Government entities.
Subtotal	26	
<b>TOTAL</b>	36	

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# The Externality Cost of Coal Combustion in South Africa

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## ABSTRACT

South Africa is endowed with an abundance of coal, which, subsequently, has provided the economy with a major source of energy from which diversification into a strong manufacturing sector could be supported. The use of coal does, however, cause various environmental damages due to pollution externalities and emissions; these are impacts that place strains and limitations on the use of other natural assets beyond the mere extraction thereof. These social costs have not been internalised by industry though and therefore this paper examines the cost of these environmental externalities that arise through the combustion of coal by South African industries. Though the paper alludes to the local impact of volatile matter and sulphur, the focus is on the cost of carbon dioxide and methane emissions. It is concluded that the monetary values of these externalities are significant and that the environmentally inclusive price (including negative environmental externalities) of coal is appreciably higher than the private or market price thereof paid by each respective industry.

### *Key Words*

Coal consumption

Combustion of coal

Coal mining externalities

Damage cost of greenhouse gas emissions

Social cost of externalities

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## 1 INTRODUCTION

South Africa is endowed with an abundance of coal, which, subsequently, has provided the economy with a major source of energy from which diversification into a strong manufacturing sector could be supported. The use of coal does, however, cause various environmental damages due to pollution externalities; these are impacts that place strains and limitations on the use of other natural assets beyond the mere extraction thereof. These externality effects have been well captured in a number of previous studies (Van Horen 1994, Spalding-Fecher 2001 and Spalding-Fecher and Matibe 2001).

Conventional pricing methods do not account for the full economic cost associated with the extraction and use of coal (especially the externality effects caused by combustion), potentially contributing to a misallocation of resources. To determine the full economic cost requires the calculation of a price for coal inclusive of the externality effects by using (i.e. burning) coal. This paper works towards this end in estimating a price for coal internalising the damage cost caused by carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) emissions due to its contribution to climate change. Reference to local pollutants such as sulphur dioxide (SO<sub>2</sub>), ash and volatile matter and their respective health impacts will be made, but no cost will be assigned to them. The impact of these emissions on water quality is also not internalised. Given these omissions, the values presented here reflect a lower bound estimate of the environmentally inclusive price (a price for coal inclusive of the negative environmental externalities) for coal per sector.

It is acknowledged that all South African industries do have significant positive impacts as well, such as

accounting methods. Unaccounted positive externalities due to the use of coal, such as the benefits of increased electrification during the period 1994-2000 under the Reconstruction and Development Programme, has also been documented (Spalding-Fecher and Motibe 2001). This study does not present the value of these since it is done for only one sector, namely electricity. Furthermore, in the previous studies mentioned the social cost of negative externalities was expressed in terms of the price of electricity and not the source of the emissions, namely coal. It is argued here that the externality cost of coal combustion should be relayed to the price of coal and not to the commodity or product produced (as conventionally done) since it obscures the fact that there might be other technologies than coal combustion for the generation of energy. In relaying the negative environmental effects of coal combustion directly to the commodity, one almost accept that there is no alternative to coal combustion and that the only way to mitigate or express the problem is by a change in the product or commodity price. This is clearly wrong. When alternative sources of energy are investigated, the appropriate price for coal in the cost benefit analysis should be the price inclusive of its negative environmental impacts.

In answering the stated question (the externality cost of coal combustion), this paper investigates the South African coal production and consumption markets in the next section. Section 3 concentrates on the theory justifying the internalisation of externalities followed by a section calculating the damage cost of carbon dioxide and methane due to their contribution to climate change. Lastly, though this paper is limited in its scope, some tentative conclusions could be drawn.

## 2 COAL CONSUMPTION IN SOUTH AFRICA

South Africa is the sixth largest producer and second largest exporter of hard coal in the world, beaten only by Australia in the exports market for 2000 (see Table 1). In 2000 the total value of the export earnings of coal sales was approximately R11 230 million or 56 per cent of the total value of coal sales (see also Table 3), though in volume terms exports only represent approximately 31 percent of the total production. Coal's apparent abundance (with reserves lasting more than a 100 years at current extraction rates (Blignaut and Hassan 2001)) coupled with relatively low coal prices (see Table 2) have encouraged the development of many energy-intensive industries, including the mining of non-energy minerals, manufacturing and electricity generation within the country (C.O.M. 2000). These represent positive externalities of having access to low cost coal and a lot of it.

**Table 1 Producers, importers and exporters of coal: 2000**

Producers	Hard coal (Mt)	Brown coal (Mt)	Importers of hard coal	(Mt)	Exporters hard coal	(Mt)
People's Rep. of China	1 171	*	Japan	133	Australia	170
United States	899	77	Korea	55	<b>South Africa</b>	<b>69</b>
India	310	22	Chinese Taipei	41	United States	57
Australia	238	68	Germany	22	Indonesia	55
Russia	169	86	United Kingdom	21	People's Rep. of China	37
<b>South Africa</b>	<b>225</b>	<b>0</b>	Spain	20	Canada	34
Germany	37	168	Netherlands	19	Colombia	30
Poland	101	59	India	18	Russia	28
DPR of Korea	67	24	France	17	Poland	24
Ukraine	81	1	Italy	17	Kazakhstan	16
Rest of the World	338	390	Rest of the World	176	Rest of the World	30
<b>World</b>	<b>3 637</b>	<b>895</b>	<b>World</b>	<b>539</b>	<b>World</b>	<b>550</b>

IEA 2001.

**Table 2 Retail price: Steam coal for industry: 2000**

	<b>US\$/t</b>
Germany	144,5
France	78,74
Korea	53,35
United Kingdom	49,58
Italy	41,97
Poland	37,35
United States	34,81
Portugal	34,61
Turkey	32,92
India	14,66
Czech Republic	14,3
<b>South Africa</b>	<b>10,38</b>
Slovak Republic	6,3

IEA 2001.

Electricity generation is one of the industries benefiting the most from the large coal reserves and the relatively cheap production thereof. ESKOM is by far the largest single producer of electricity in South Africa, and is currently the fifth largest electricity utility in the world in terms of both sales and capacity (ESKOM 1999). Not only is it such a large producer of electricity, its share in domestic production has also increased considerably since 1960. In 1960 ESKOM produced 62,3 per cent of the total electricity and 98,3 per cent in 1999, mainly through its coal-fired power stations. In 1960, all of the electricity produced was coal-based, but due to other technologies such as nuclear power, coal's contribution declined slightly to approximately 93 per cent in 1999. Consequently, ESKOM is the largest single consumer of coal in South Africa, absorbing approximately 41 per cent of the total coal production in 2000 (approximately 60 per cent of the domestic market). Its consumption of coal increased more than seven fold over the period under consideration from 12,5 million tonnes to 91,8 million tonnes in 2000. For comparative purposes, this consumption of coal should be seen in the light of the fact that total coal exports comprised 31 per cent of the market in the same year (see Blignaut and De Wet 2001). Table 3 provides a breakdown of the consumption of coal per industry in 2000.

**Table 3 Coal sales by sector: 2000**

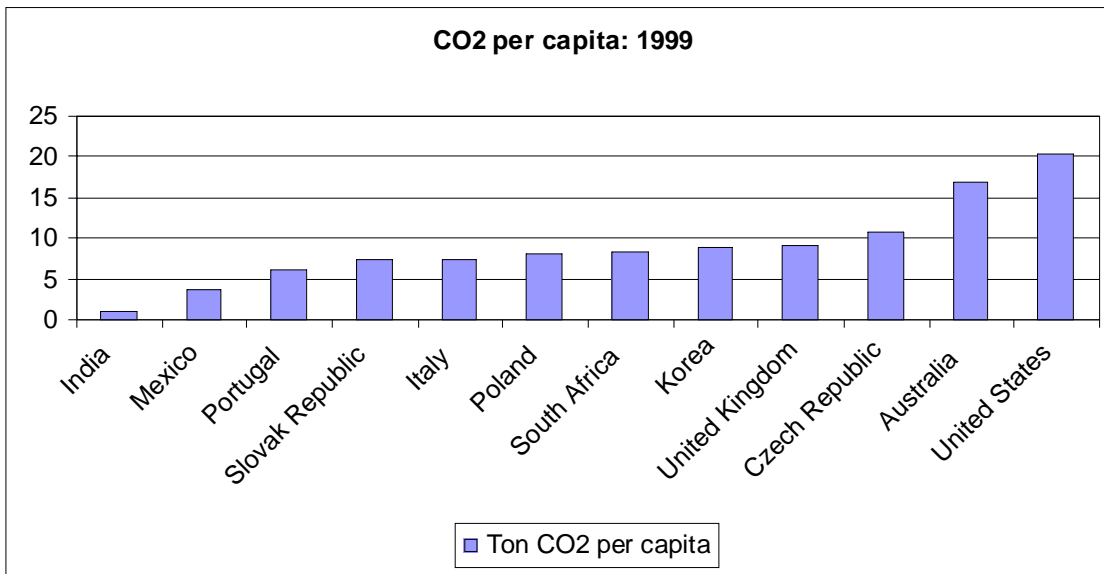
	Mass (t)	% share	Value (R'000)	% share	Price (R/t)
ISCOR	1 583 865	0,71	378 669	1,89	239,08
Metallurgical	1 272 014	0,57	190 016	0,95	149,38
Agriculture	69 053	0,03	7 471	0,04	108,19
Iron and Steel	2 881 311	1,29	2 98 751	1,49	103,69
Industries	2 630 809	1,17	258 464	1,29	98,25
Chemical Industries	1 080 816	0,48	105 575	0,53	97,68
Merchants and Domestic	3 920 241	1,75	374 600	1,87	95,56
Gold and Uranium Mines	24 043	0,01	2 232	0,01	92,83
Other Mining	120 998	0,05	10 565	0,05	87,32
Water	146 534	0,07	11 946	0,06	81,52
Synthetic Fuels (SASOL)	46 334 788	20,67	2 845 540	14,23	61,41
Cement and Lime	1 071 221	0,48	65 532	0,33	61,17
Electricity (Non-ESKOM)	1 556 304	0,69	95 126	0,48	61,12
ESKOM	91 811 056	40,96	4 129 021	20,64	44,97
Brick and Tile	176 517	0,08	7 525	0,04	42,63
Exports	69 456 361	30,99	11 230 234	56,14	161,69
<b>Total</b>	<b>224 135 931</b>	<b>100</b>	<b>20 002 544</b>	<b>100</b>	<b>56,77</b>

DME 2001.

From the above it should be clear that the coal industry is an important one in the South African economy, both for domestic downstream economic activity and earner of international exchange. Many of the industries listed above would never have been able to develop to the extent that they have if it had not been for the availability of coal. But, as stated above and clearly evident from Tables 2 and 3, the price of coal varies significantly among sectors, with ESKOM, comprising 60 per cent of the domestic market, paying very low prices, also when compared internationally. The low price of coal can be attributed to the low quality of coal, the fact that ESKOM owns its own coal mines, and bulk purchases of coal.

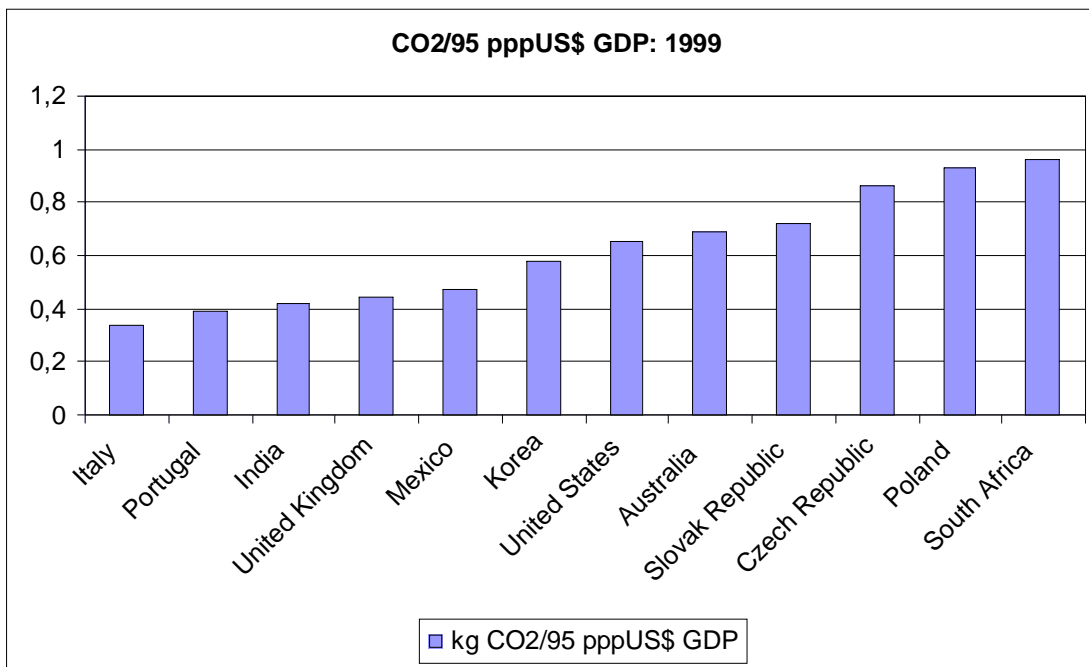
The low price of coal, however, stimulates consumption of coal across all sectors rather than conserving it (Doppegieter *et al.* 1998 and 1999). Consuming low-quality coal, however, has its major disadvantage in the form of emissions, which coincide with the combustion process. In 1999 South Africa contributed 1,6 per cent towards global CO<sub>2</sub> emissions and expressed in terms of per capita and per purchase power parity adjusted GDP (or emissions intensity), South Africa's emissions are amongst the highest in the world, as shown in Figures 1 and 2 below (IEA 2001). South Africa, being a developing and a non-annex 1 country is not obliged to reduce its carbon emissions, but from the evidence shown here its carbon footprint are amongst the highest in the world and it would therefore be of strategic importance to consider options to reduce the emissions load before it will have to do so at high cost later.

**Figure 1**



Source: IEA 2001.

**Figure 2**



Source: IEA 2001.

But what is the social and environmental cost of these emissions, which is not captured in the market price for coal? This is the subject of the next section.

### 3 COAL MINING EXTERNALITIES

Free markets, theoretically, provide goods and services, resolve shortages and surpluses, and eliminate inefficiencies through the pricing mechanism and thereby lead to the socially efficient allocation of resources without the intervention of government action (Callan *et al.* 2000; Khan 2000). The role of this *invisible hand* postulates that in the seeking of their own selfish goals, consumers and producers unknowingly make decisions that improve the well being of society. Evidently, the efficiency with which markets function is paramount to the sustainability and improvement of society's overall welfare, however, the conditions for such market efficiency is very strong and a long list of possible sources for market failure exist, namely:

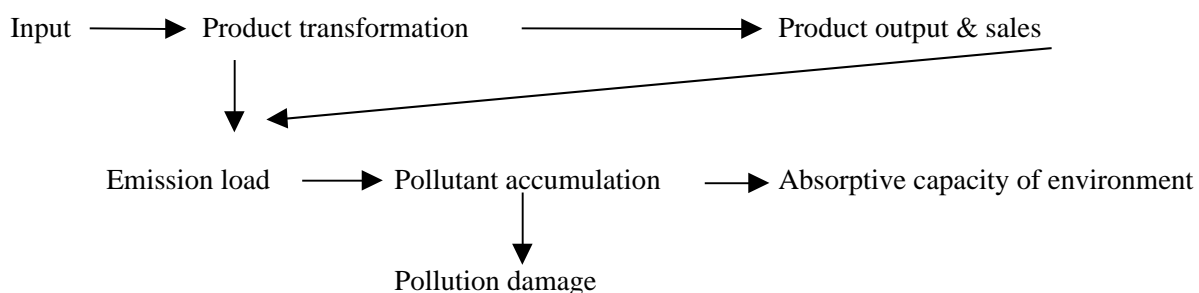
- poorly defined property rights,
- the existence of spill-over effects or externalities,
- pervasive and high transaction costs,
- barriers to market entry and trade,
- short-sightedness to current global and local needs,
- high levels of uncertainty and risk associated with the transaction,
- irreversibility of transactions,
- absence, weak or corrupt institutions such as the government,
- failure to assign representative prices to the resource, and
- the nature of the good, such as public goods or communal resources<sup>7</sup>.

Intrinsic to the process of production, consumption and the well-functioning market, is the acknowledgement that materials in some form are used as inputs in the commodity process. These inputs are invariably sourced from the natural environment. The economic process is dependent on natural resources, which in turn adhere to the fundamental laws of the natural sciences. The law of mass balance implies that:

*... the mass of matter that is used as an input into an activity, must be equivalent to the mass of matter that results in the output activity. Any changes in mass that occur during the transformation process, resulting in an output mass lower than an input mass are attributable to waste (Kahn 2000).*

Economic activity, in the fuller context of materials balance, gives rise to residuals or wastes that may damage the existing natural resource base when released into the environment. A prime example of an economic activity solely dependent on natural resources, is that of mining. Minerals frequently lie in forms and structures that make them difficult to extract and process, consequently, many by-products in various forms of waste are generated. An example of the flow of energy is shown in Figure 3.

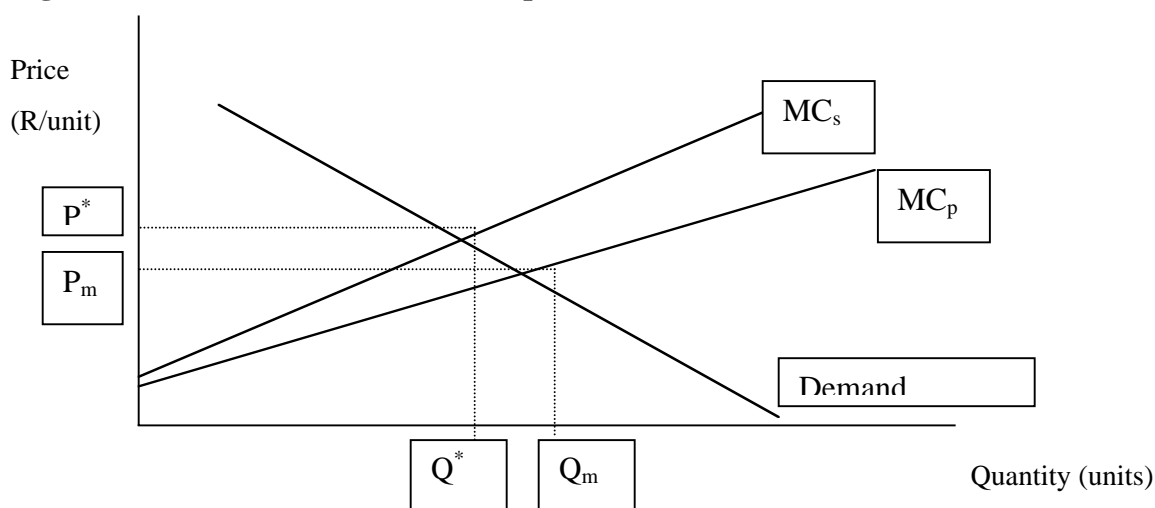
**Figure 3 Relationship between input, production and pollution**



Adapted from: Tietenberg 1992.

Market failures, due to the non-incorporation of environmental related impacts, contribute to a disparity between the private costs and social costs associated with the use of any commodity, i.e. coal, as shown in Figure 4 below.

**Figure 4 Market allocation with pollution**



Source: Tietenberg 1992.

Using any commodity without internalising its social costs will result in the misallocation of resources. In the example above illustrated by Figure 4, the demand for a product is indicated by the demand curve. Without internalising any polluting effects, the producing firm will only have a marginal private cost curve ( $MC_p$ ). Internalising any social cost that coincide with the production of the product, society will have a marginal social cost curve ( $MC_s$ ) which includes both social and private costs and is hence laying at a higher level than the  $MC_p$  curve. A number of conclusions can be drawn from Figure 4, namely:

- the output of the commodity is too large ( $Q_m > Q^*$ ),
- the price of the product is too low ( $P_m < P^*$ ),
- as long as costs are external there is no incentives to produce less pollution per unit of output,
- hence too much pollution is produced,
- recycling and reuse of polluting substances are discouraged since release into the environment is too cheap (Tietenberg 1992:47-48).

The question that arises is: What is the social cost assigned to the use of coal?

#### 4 THE CLIMATE CHANGE COST OF COAL COMBUSTION

##### Research method and data

The tonnes of coal produced and disaggregated by sector of demand for 2000 were obtained from the Minerals Bureau, South Africa (DME 2001 - see also Table 3). To quantify the volume of sulphur dioxide ( $SO_2$ ), methane ( $CH_4$ ), carbon dioxide ( $CO_2$ ), ash and volatile matter various conversion factors were used and applied to the volume of coal purchased in 2000 by each of the sectors.

The conversion factor for  $SO_2$  was obtained by calculating the sulphur (S) content in the coal using the percentages as in Pinheiro *et al.* (1997) (see Annexure A) and weighing it with the 2000 consumption levels of either anthracite or bituminous per sector and multiplies the total volume of sulphur by a factor of 2 to

determine the weight of SO<sub>2</sub>. The atomic weight of sulphur is 32 and that of oxygen 16, therefore the total atomic weight of SO<sub>2</sub> is 64 and 64/32 equal 2 and hence the multiplication factor.

The conversion factor for methane was determined from the IPCC 1996 guidelines of 0,7kg of CH<sub>4</sub> per TJ coal, which transcribes to 24,7 kg CH<sub>4</sub> per tonne of coal. A conversion factor for CO<sub>2</sub> was obtained by calculating the carbon content in the coal using Pinheiro *et al.* (1997) and multiplying the total volume of carbon by 3,667 to determine the weight of CO<sub>2</sub> in a similar way as has been done for SO<sub>2</sub>. The atomic weight of carbon is 12 and that of oxygen 16, therefore the total atomic weight of CO<sub>2</sub> is 44 and 44/12 equal 3,667. The ash and volatile matter content of the coal purchased by each industry has been calculated in the same way using the percentages as determined by Pinheiro *et al.* (1997).

While the volumes of sulphur, ash and volatile matter have been calculated, the social cost associated with their emissions are not since they are local pollutants and the damage caused by these pollutants depends very much on the demographic composition of the exposed population, level of exposure and dose-response functions. This study only quantifies the damage cost of the global pollutants, CO<sub>2</sub> and CH<sub>4</sub>, in their contribution to global climate change.

Sandor (2001) estimates the price for CO<sub>2</sub> in 2000 between US\$5/tonne and US\$10/tonne. For this analysis a conservative \$2,50/tonne and \$5,00/tonne are used. The price for methane was derived from those for carbon dioxide based on the widely accepted principle of 1 tonne CH<sub>4</sub> that has the same global warming potential as 21 tonnes carbon dioxide, hence multiplying the price for carbon dioxide by 21 to determine the price for CH<sub>4</sub>, namely US\$52,5/tonne and US\$105/tonne respectively.

The Rand values for the global damage cost were obtained adjusting the dollar price using the 2000 exchange rate (since all the prices and volumes were for 2000), namely R6,9353/\$ and multiplying by the tonnes produced for each respective industry. This implies a price of R17,34/tonne or R34,68/tonne for CO<sub>2</sub> and R364,1/tonne and R728,21/tonne for CH<sub>4</sub>.

### Research results

The volume of S, SO<sub>2</sub>, CH<sub>4</sub> and CO<sub>2</sub>, ash and volatile matter produced by each industry based on the volume of coal combusted in 2000 are displayed in Table 4 below. It should be noted that the export sector is not shown since it is unknown how the coal is used in the various countries of their destination. Another important aspect is the fact that the emissions of the two main consumers of coal, namely ESKOM and SASOL, have been verified against their own published emissions as per their respective environmental reports for 2000 (ESKOM 2001 and SASOL 2001b). The totals shown in the last row is inclusive of the figures of these two companies and not that which has been calculated. Interesting to note also that for both ESKOM and SASOL the coal consumed according to their figures is more than what is reported by the Department of Minerals and Energy.

From this calculation a total of 2,084 million tonnes SO<sub>2</sub>, 3,820 million tonnes CH<sub>4</sub>, 252,345 million tonnes of CO<sub>2</sub>, 39,190 million tonnes of ash and 5,192 million tonnes of volatile matter are produced by industries using coal in 2000.

ESKOM emitted 1,78 million tonnes SO<sub>2</sub> using the formula described above, which over estimated the emissions by approximately 15 per cent since ESKOM estimates its emissions as being 1,505 million tonnes. Given a total emission of 2,084 million tonnes ESKOM are producing 72 per cent of the county's sulphur dioxide. SASOL's contribution of 293 kiloton is 14 per cent of the total SO<sub>2</sub> load. The calculated figure for SASOL is, however, almost three times higher, namely 899 kiloton.

Regarding CO<sub>2</sub> emissions, the picture is reversed. According to the calculations here, ESKOM emitted 143 million tonnes of carbon dioxide, ESKOM itself estimate their emissions to be 161,2 million tonnes (ESKOM 2001) or 64 per cent of the total CO<sub>2</sub> emissions from industry. This represents an underestimation of 11 per cent by the formula. With regard to SASOL, the calculated figure<sup>8</sup> (taking into account that not all

the coal is combusted in boilers but some goes into a chemical gasification process) CO<sub>2</sub> emissions are 66,3 million tonnes and represent an 11 per cent overestimation compared to SASOL's own estimate of 57,7 million tonnes, which are 23 per cent of the total CO<sub>2</sub> emissions by industry. All other industries are therefore responsible for only 13 percent of the CO<sub>2</sub> emissions, which relates very well to the fact that they consume only 10,3 per cent of the coal.

Regarding ash, the formula and ESKOM and SASOL's own estimates are closely related as well. ESKOM estimates its ash production at 24,6 million tonnes (63 per cent of the total) while the formula estimated it to be 27,8 million tonnes (an 11 per cent overestimation) where SASOL estimates its ash production at 11,8 million tonnes (30 per cent of the total) and the formula estimated it to be 12,5 million tonnes (an overestimation of 6 per cent). The formula was, however, particularly weak in estimating volatile matter and all the numbers should be treated with caution.

As discussed before, the damage and health impacts of the local pollutants SO<sub>2</sub>, ash and volatile matter have not been cost, nor has the change in surface and ground water quality as a result of these emissions been quantified since they require site specific data. With regard to ESKOM and electricity generation Van Horen (1996) and Spalding-Fecher and Motibe (2001) has done some work in this regard. This study focuses on calculating the damage cost due to the emission of the global pollutants CO<sub>2</sub> and CH<sub>4</sub> due to their contribution to climate change. These calculations are shown in Tables 5 and 6 below.