Sustainable development policies and measures

Institutional issues and electrical efficiency in South Africa

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TABLE OF CONTENTS

LIST OF TABLES

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LIST OF FIGURES

1. Introduction

Climate change is a global problem requiring the cooperation of all countries to be addressed effectively. Emissions from the industrialised North have thus far been greater than from the developing South, but they are growing rapidly in the latter.[2] The principle of 'common, but differentiated responsibilities' between industrialised and developing countries is well-established in the negotiations. However, co-operation between North and South has been limited in the negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). Climate change is not seen as a priority by developing countries, which are preoccupied by the challenges of meeting basic development needs. As discussions on actions beyond the first commitment period under the Kyoto Protocol (2008-2012) draws closer, the question of how developing countries might participate in the effort against global warming becomes more urgent.

The importance of sustainable development has long been recognised in the UNFCCC process. Article 3.4 of the Convention (1992)states as a principle that:

> Parties have a right to, and should promote, sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate to the specific condition of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change.

The negotiations have, however, tended to focus on emissions targets more than sustainable development, due in part to the predominance of the interests of Northern countries. The links between sustainable development and climate change have received increasing attention in the recent literature.(ENDA-TM 2001; Beg et al. 2002; Davidson 2002; KEI 2002; Markandya & Halsnaes 2002; Shukla et al. 2002; Winkler et al. 2002a; Downing et al. 2003; IIM 2003; Munasinghe & Swart 2005)

This paper outlines and proposes a pledge by developing countries to implement sustainable development policies and measures (hereafter 'SD-PAMs'). Development is a key priority for decision-makers in developing countries, so that building climate change policy on development priorities would make it attractive to these stakeholders. Starting from development objectives and then describing paths of more sustainable development that also address climate change may be the easiest way for many developing countries to take the first steps in longer-term action on climate change. The approach has a basis in the Convention, which, together with a proposed reporting structure, would provide sufficient stringency for a first step.

The paper is organised as follows. The next section outlines the SD-PAMs approach in concept, and specifies the practical steps a country would have to take to define a pledge. Section 3 provides a detailed case study to show how energy efficiency in South African industry would work as a SD-PAM. The case study quantifies the results for energy savings, local environmental benefits (air pollution and water), job creation potential, as well as the co-

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[2] IPCC,(2001: 89) but note the caution about use of annual emission for comparison on page 90.

benefits of CO_2 emission reductions. The fourth section develops thinking around institutional and policy issues for SD-PAMs, discussing how this approach might be realised in the UNFCCC system and what national capacity is needed – and already exists – to implement SD-PAMs.

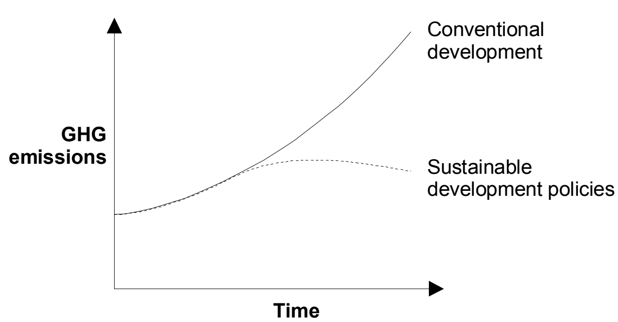
2. The SD-PAMs approach[3]

The SD-PAMs approach starts with the development objectives and needs of developing countries. Countries begin by examining their development priorities and identify how these could be achieved more sustainably, either by tightening existing policy or by implementing new measures. The next step is to identify synergies between sustainable development and climate change, that is, those SD-PAMs that also result in reductions of greenhouse gas (GHG) emissions. To obtain a realistic picture of the impact of a basket of SD-PAMs, those policies and measures that increase GHG emissions also need to be identified.

2.1 Starting from development, shifting to sustainability

The SD-PAMs approach suggests that we work backwards from a desired future state of development. Key development objectives typically include poverty eradication, job creation, food security, access to modern energy services, transport, drinking water, education, health services and land. Energy is an important requirement for many of these objectives. Sustainability, for the purposes of this paper, is taken to mean providing services for basic human needs in a way that can continue over time, resulting in less impact on the environment, and providing more social benefits and long-term economic development. Development is needed because the number of houses to be built, mouths to be fed and households to be lighted and heated is growing. In meeting these basic needs, different paths are possible – and the aim of SD-PAMs is to shift towards a more sustainable path of development. In describing sustainable development paths to meeting such objectives, the hypothesis is that, on balance, GHG emissions will also be reduced relative to a conventional development path (shown graphically in Figure 1). If countries act early to move to greater sustainability in their development path, they will start 'bending the curve' of their emissions trajectory.(see Raskin et al. 1998)

Figure 1: Hypothesis that SD-PAMs will reduce emissions below BAU



The IPCC's Working Group III has broadened the analysis of climate change mitigation to the context of 'development, equity and sustainability' in its contribution to the Third Assessment report.(Banuri & Weyant 2001) The challenge considered in this paper is to turn the conceptual link between sustainable development and climate change into a workable approach.

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[3] This section of the paper draws on the SD-PAMs concept as described in earlier work, notably (Winkler et al. 2002a)and elaborated in.(Winkler et al. 2002b)

2.2 Steps to apply the SD-PAMs approach

In practice, a country might undertake eight steps in considering its commitment to SD-PAMs:

1. Outline future development objectives,[4] where possible quantifying the expected benefits and possible risks. If a long-term vision has been articulated, back-casting to immediate action is possible. Otherwise, it may outline shorter-term goals.
2. Identify policies and measures that would make the development path more sustainable, primarily for reasons other than climate change (such as greater social equity and local environmental protection) while maintaining or enhancing economic growth. The sustainable development benefits should be quantified as far as possible. These SD-PAMs may be:
    a. existing sustainable development policy that is not fully implemented; or
    b. new policies and / or more stringent measures.
3. Register nationally selected SD-PAMs in a registry maintained by the UNFCCC secretariat.
4. Mobilise investment and implement SD-PAMs
5. Set up national monitoring system to track implementation of SD-PAMs
6. Review of SD-PAMs in SD units, either as part of national communication or a specific review
7. Quantify the changes in GHG emissions of particular SD-PAMs, which should be reported in accordance with the Convention or other reporting provisions.
8. Summarise the net impact of a basket of SD-PAMs on development benefits and GHG emissions.

Comparing the results from steps 2 and 3 will show which SD-PAMs create synergies between sustainable development objectives and climate change policy. In other cases, there will be conflicts between these goals. The information relating to climate change benefits will be useful in implementing and funding SD-PAMs, as those offering greater GHG emissions reductions can potentially attract climate change related funding. Those with greater sustainable development benefits, but no climate benefits, need to attract other funding (see section 4.2.4).

2.3 Previous examples / case studies

Examples of SD-PAMs from South Africa have been presented in previous work.(Winkler et al. 2002b, 2002a) Table 1 summarises some of the examples from South Africa, focusing on the energy and housing sectors. From this initial consideration, however, it appears that the majority of SD-PAMs have more potential for reducing GHG emissions than to increase emissions. The change in an energy price (the poverty tariff) is the only example of an increase here, yet its impact on overall emissions is small. Since SD-PAMs already include a shift to greater sustainability relative to conventional development, synergies are more likely.

Table 1: Summary of changes in carbon dioxide emissions for selected SD-PAMs in South Africa

Source: Winkler et al (2002b)

SD-PAM	*Sustainable development benefits*	*Percentage of CO_2 emissions, 1999*	
		Sectoral	*National*
National electricity efficiency improved by 5% (2010)	39 000 additional jobs R800 million additional income	N/a	-2%

[4] The default would be to examine development objectives for all sectors. However, some pre-screening of sectors that are deemed most likely to show synergies between sustainable development and climate change could help limit the analysis to a more manageable subset of sectors.

End-use Energy efficiency (2010)	Energy savings and load management by utility	5% of CO_2 from electricity	-2%
Increased share of cleaner electricity of 5% by 2010	Reduced local air pollution and fuel costs, increased diversity		-3%
Poverty tariff	Savings on electricity and lighting and entertainment services from free electricity of 20 – 60 kWh / household / month for 1.4 million poor households	+1.6% of residential CO_2 emissions	+0.2% (upper bound estimate)
Energy efficiency in low-cost housing	Household energy savings, reduced indoor air pollution, improved health and increased levels of comfort	-0.6% to -7% of residential CO_2 emissions	-0.01% to -0.2%
Note: The latest inventory of SA's GHG emissions is for 1994, so more recent emissions data in used which includes CO_2 only. CO_2 contributed more than 80% of SA's total GHG emissions in both the 1990 and 1994 inventories.			

The examples of SD-PAMs from the energy and housing sectors have illustrated some measures with strong sustainable development benefits, some with potential for GHG emission reduction and some that meet both objectives. The analysis is not comprehensive - conducting a complete analysis across all sectors would require an inter-disciplinary team, significant time and data. However, the modeling framework employed for the current paper has the potential to provide a more systematic overview. Many non-Annex I countries would require assistance in conducting such analysis.

The poverty tariff provides an example of a conflict between sustainable development and GHG reductions. The magnitude of the effect is uncertain, however, since the degree to which electricity replaces other fuel use is not well known.

A number of synergies between shifts in sustainable development and GHG reductions are apparent in the energy sector. Energy efficiency is the clearest example, saving on energy costs while reducing GHG emissions. SD-PAMs that promote national electricity efficiency achieve electricity savings, create jobs, add to income and reduce GHG emissions. End-use efficiency provides savings on energy bills for households, reduces indoor use of polluting fuels, proves health and levels of comfort. At the same time, efficiency can assist utilities with managing peaky load profiles. In the current paper, a more detailed case study based on an energy modeling framework is presented.

Provision of cleaner electricity has important local air quality benefits, apart from its co-benefits of reducing GHGs. A greater diversity in the fuel mix is a major goal of energy policy.

Cost has not been explicitly considered in this analysis. In combining SD-PAMs in a basket of measures, some measures that require additional investment have net negative costs over their lifetime. Savings made through energy efficiency could potentially be used to promote a cleaner energy mix. The case study in this paper provides more detailed cost estimates.

3. Using electricity efficiently in South African industry

Efficient use of electricity in South African industry can promote local development goals. Government plans to embark on an ambitious energy efficiency program, explicitly motivated by a concern for the three dimensions of sustainable development – economic, social and environmental (DME 2005). The strategy aims to contribute to two major energy policy objectives: affordable energy for all, and to minimize the effects of energy usage upon human health and the environment (DME 1998).

The extent to which these goals are met are a function of the technical measure. And the extent to which the measure is adopted is a function of the policy, context and the vigour of its implementation. Previous examples of work already summarised did not include a detailed estimate of all of the effect of SD-PAMS on stated government goals. Work which does include a detailed multi-criteria analysis of development goals and technical measures (Howells & Laitner 2003)did not attempt to quantitatively relate these back to specific policies. Though this and other work (Howells & Laitner 2005) did identify which technical measures were most effective in meeting different development scenarios. In this work[5] we analyse the effect of energy efficiency policies on sustainable development goals. We consider the effects of meeting government energy efficiency targets as well as the proposed effects of individual targets compared to a baseline scenario. We consider a range of interventions in industry[6] (i.e. the manufacturing sector) to promote greater energy efficiency.

3.1 Brief review of government EE strategy

To put the wide variety of energy-efficiency measures together in a **policy framework**, the Department of Minerals & Energy (DME) recently published a 'draft energy efficiency strategy'. The strategy set a goal for an improvement in energy efficiency of 12% by 2014 relative to projected consumption.(DME 2004) While the DME document covers all energy, the National Electricity Regulator (NER) has approved policy for efficiency in the electricity sector in particular, with an 'energy efficiency and demand side management policy'.(NER 2003)

The rationale for adopting the energy efficiency strategy is to meet a series of development goals. The emphasis is on national rather than global goals (such as GHG mitigation), however where carbon funding can be used to encourage energy efficiency, according to the draft strategy, it should be taken advantage of. This underscores the paradigm that GHG mitigation regimes should be consistent with the development goals of emerging nations (Winkler et al. 2002c; Heller & Shukla 2003; Bradley et al. forthcoming). The goals South Africa hopes to meet by the adoption of energy efficiency measure can be grouped according to the following themes: Social, environmental and economic sustainability. Specific goals are reported in Table 2.

For electricity specifically, the DME target a saving of 12% over a business as usual scenario. The policies which are being considered to meet this target include:

1. Energy efficiency standards
2. Appliance labelling
3. Education, information and awareness
4. Research and technology development
5. Support of energy audits
6. Monitoring and targeting
7. Green accounting

[5] The work described in section 3, including the modeling and policy analysis, is part of PhD research being undertaken by Mark Howells at the University of Cape Town's Energy Research Centre.

[6] 'Industry' here does NOT include the mining sector. With essentially the same interventions, additional benefits would be possible – mining accounts for about a third of the final energy consumption of total industry plus mining.

In order to derive these savings estimates, the DME commissioned modelling work to determine both potential and likely savings from the implementation of these policies based on international experience[7](Hughes et al. 2003).

We further develop the analysis to model other attributes associated with the DME's stated development goals, as specified in Table 2.

Table 2: Goals to be met by energy efficiency

Source: DME (2004)

Goals	Metric / proxy for this goal in the analysis here
Social sustainability	
Goal 1: Improve the health of the nation Energy efficiency reduces the atmospheric emission of harmful substances such as oxides of sulphur, oxides of nitrogen, and smoke. Such substances are known to have an adverse effect on health and are frequently a primary cause of common respiratory ailments.	**Goal 1**: Tons of sulphur dioxide, nitrogen oxides and total suspended particulates
Goal 2: Job creation. Spin-off effects of energy efficiency implementation. Improvements in commercial economic performance, and uplifting the energy efficiency sector itself, will contribute to nationwide employment opportunities.	**Goal 2**: Thousands of jobs created
Goal 3: Alleviate energy poverty Energy efficient homes not only improve occupant health and wellbeing, but also enable the adequate provision of energy services to the community at an affordable cost.	**Goal 3**: Number of households with access to electricity; *and* lower residential energy costs
Environmental sustainability	
Goal 4: Reduce environmental pollution Energy efficiency will reduce the local environmental impacts of its production and use	**Goal 4**: Tons of sulphur dioxide, nitrogen oxides and total suspended particulates avoided; and reduction of specific water use
Goal 5: Reduce CO_2 emissions Energy efficiency is one of the most cost-effective methods of reducing GHG emissions, and thereby combating climate change. Addressing climate change opens the door to utilising novel financing mechanisms, such as the CDM, to reduce CO_2 emissions.	**Goal 5:** Tons of CO_2 emitted and abatement cost (R / t CO_2)
Economic sustainability	
Goal 6: Improve industrial competitiveness	**Goal 6**: Cost of energy supply in millions of rands
Goal 7: Enhance energy security Energy conservation will reduce the necessary volume of imported primary energy sources, crude oil in particular. This will enhance the robustness of South Africa's energy security and will	**Goal 7:** Level of energy imports in rand and per unit of energy[8]

[7] This work was indicative as it did not consider the administrative burden in detail. The work did however produce a range of savings as a function of policy implemented effectively. It adjusted the potential savings to reflect South African fuel costs and the costs of the efficiency measures. It also estimated the extent to which specific measures were adopted. (South African electricity costs are the lowest in the world and therefore efficiency measures that would be otherwise be economic are not. Non-economic measures are not considered or accounted for in the savings estimates made.) While implementing SD-PAMS affects many aspects of the energy system, such as emissions, jobs and costs, this work only estimated the potential energy savings as a function of specific policy.

[8] This result is however not reported as we consider only the displacement of locally mined coal, which is used to generate the electricity saved.

increase the country's resilience against external energy supply disruptions and price fluctuations. **Goal 8: Defer the necessity for additional power generation capacity** It is estimated that the country's existing power generation capacity will be insufficient to meet the rising national maximum demand by 2007-2012. Energy efficiency is integral to Eskom's Demand Side Management programme insofar as it contributes 34% towards the 2015 demand reduction target of 7.3 GW .	**Goal 8:** Power station investment timing expressed as MW of supply avoided

3.2 National energy model

We build on previous work which determines the level of energy saved by measure as a function of policy, in order to determine the effects of implementing these energy efficiency policies (Hughes et al. 2003). We then determine how different development goals are affected by the adoption of these measures using a previously developed model (Howells & Laitner 2005).

In order to illustrate the effects of these SD-PAMS we develop two scenarios. The first is a reference scenario reflecting the continuation of current development trends, and the second is a policy scenario where energy efficiency is implemented as a SD-PAM. The differences between the two scenarios show the impacts that energy efficiency can have on local sustainable development, and on emission reductions.

3.2.1 Description of model

To ensure consistent accounting for the attributes of the energy system and the role that energy interventions play in that system, we use the MARKAL (short for market allocation) energy model.[9] A full description of the model used is contained in Howells 2005. We further develop the standard formulation of this model to incorporate rebound effects.

We calibrate the model using detailed sector-by-sector demand projections (Howells 2004b) and identify a limited set of power investments based on recent electricity sector planning (NER 2004). Based on this, we assume that open-cycle gas peaking plant and coal-fired power station investments will be used to meet marginal increases in electricity demand. In order to calculate the attributes of the system, coefficients gathered from various sources are used to relate energy use with the attribute considered. Gaseous emissions per unit of fuel consumed are taken from IPCC (1996)(1996), van Horen,(1996) water emissions data from van Horen,(1996) particulate emissions from Howells and de Villiers,(1999) and indicators for the "difficulty of implementation" from Howells and Laitner (2003). Job creation and the effects of other sector growth are calculated using the input output approach elaborated in previous work (Spalding-Fecher et al. 2003; Howells & Laitner 2005).[1] We assume that fuel significant fuel switching is limited over the scenario period (DME 2004).

Sector specific rebound effects are included by adopting a non-standard (Howells 2004)model structure (see Sato et al. (2000) for an example of a standard structure). While changes in energy demands (and the resulting changes in attributes) have been accounted for in variations of MARKAL (such as MARKAL-MACRO and MARKAL-MICRO,(Loulou et al. 2004) this represents novel use of fuel demand multipliers in response to changes in the energy sector within the MARKAL reference energy system.

3.2.2 Reference case

[9] ETSAP (Energy Technology Systems Analysis Program). 2005. www.etsap.org

The reference case is a business as usual scenario, without the SD-PAMS policies described in the DME's energy efficiency strategy. It draws primary assumptions relating to electricity demand growth from the recent National Integrated Resource Plan (NER 2004) of the National Electricity Regulator. These assumptions are consistent with the previous Integrated Energy Planning exercises of the Department of Minerals and Energy.(DME 2003) The "primary planning assumptions" are summarised below:

- A net discount rate of 10% is assumed
- An average medium term economic growth rate of 2.8% is expected
- A low penetration of DSM is expected and this is in line with current commitments
- The horizon of the scenarios is from 2005 to 2020
- Structural changes from energy intensive industry continue at historical rates

The reference case therefore represents BAU implementation of government policy. Its consistency with official plans for the broader energy sector and the important electricity sub-sector make it a useful benchmark against which to assess new policy interventions.

3.2.3 Policy scenario

Next we consider a policy scenario in which the SD-PAMS policies listed in section 3.1 are implemented to meet the DME's energy efficiency target as it applies to electricity savings in industry. In order to realise the target, we consider the specific technological measures to be implemented and that proportion of electrical savings that would accrue to each given the SD-PAMS and targets chosen.

The specific measures we consider are described by Howells and Laitner (2003) and Trikam (2002). Assumptions relating to the characteristics of these options including aspects such their economics, job creation potential, rebound effects and cost differences associated with local content are described in Howells and Laitner (2005). A short description of the measures is given below:

1. Variable speed drives: These drives reduce unnecessary power consumption in electrical motors with varying loads
2. Efficient motors:(ERI 2000a) These motors are available at higher cost. Efficient motors can reduce power consumption, but may require modifications because running speeds are generally higher than for inefficient motors.
3. Compressed air management:(ERI 2000a) This measure is easily achieved and often results in significant savings at low cost.
4. Efficient lighting:(ERI 2000a) These measures take advantage of natural lighting, more efficient light bulbs and appropriate task lighting.
5. Heating, ventilation and cooling ((ERI 2000b): These measures are for maintaining good air quality and temperature and can commonly be improved through better maintenance and the installation of appropriate equipment.
6. Thermal saving:(ERI 2000b) Thermal saving refers to more efficient use and production of heat. For steam systems in particular we consider condensate recovery and improved maintenance.

The measures apply to all industrial sub-sectors. The extent to which they apply, however, differ as different industrial sub-sectors consume energy for different "end-uses". A summary of electricity consumption by end-use can be found in Howells & Laitner (Howells & Laitner 2005).

The savings accruing to each measure is summarised in Table 3 and this is adapted from Hughes et al (2003). We compute the effects of this scenario in terms of the development goals listed in Table 2 and compare these to the base case.

Table 3: Savings by measure for the policy scenario

Source: adapted from Hughes et al. (2003)

Technical energy efficiency saving measure							
Steam system	Other thermal measures	Efficient motors	VSDs	Efficient lighting	Compressed air saving	HVAC	Refrigeration
Percentage of industrial electricity saved to meet DME targets by 2014							
0.16%	1.26%	2.21%	2.21%	1.89%	3.16%	0.63%	0.47%

The quantity of energy saved by sector differs by sector, an approximate electrical energy saving by industry is given in Table 4.

Table 4: Percentage of electricity saving by industrial sub-sector

Source: adapted from Howells ((Howells & Laitner 2005))(Howells in press)

Sector	***Estimate of electrical energy saving***	***Ranking***
Iron and steel	32%	1
Wood and wood products	20%	2
Chemicals	18%	3
Food and beverages	8%	4
Non metallic minerals	8%	5

3.2.4 Discussion of results

The effects on the energy system are shown by comparing the SD-PAMS to the reference case (Table 6). Since the SD-PAMs relates to industrial energy efficiency, there are large energy savings of about 3% of national energy consumption (about 5% of industrial demand and 12% of industrial electricity supply). The savings reflect the cost of saved energy within the overall energy system, including power station investment, fuel savings, savings in transmissions and distributions costs and the investment costs of the energy efficiency measures. If the energy savings were compared only to industrial energy consumption, they would be approximately 5% both in 2014 and 2020. The particular measures generating savings of electricity are shown in Table 5.

Table 5: Electricity saving by measure

Measure	*Percentage of total electricity savings*	*Ranking*
Compressed air saving	26%	1
VSDs	18%	2
Efficient motors	17%	3
Efficient lighting	12%	4

Load shifting	9%	5
HVAC	6%	6
Other thermal measures	6%	7
Refrigeration	4%	8
Steam system	1%	9

Net jobs are calculated through the economy, and this is calculated within MARKAL by adding the job gains and losses through the "operation life" and initial "investment" in energy efficient technologies in question, as these are invested in.

Table 6: Implications of industrial energy efficiency on costs, pollutants and jobs

	2014	*% saving in total energy system*	*2020*	*% saving in total energy system*	*Units for absolute numbers*
Annual energy savings	76	3%	93	3%	PJ
Annual cost savings	4.1[10]	est. 8%	1.2	est. 2%	Billion Rand
Avoided investment in power stations	3600	est. 7%	4400	est. 7%	MW saved
Pollutants avoided					
Carbon dioxide	20	Est. 4%	24	est. 5%	$MtCO_2$
Oxides of nitrogen	84	Est. 5%	102	est. 5%	kt NOx
Sulphur dioxide	204	Est. 6%	252	est. 6%	kt SO_2
Total suspended particulates	23	Est. 4%	28	est. 4%	kt TSP
Water savings	455	Est. 5%	558	est. 5%	Gl (10^9 litres)
Additional jobs created	40 000		60 000		Jobs
Cost of abatement	-34		-8[11]		$ / tCO2-eq

Notes: We choose to report the savings to the entire energy system. Clearly the benefit to industry and to the portion of the energy system dedicated to meeting its energy need is proportionally bigger than the overall effect. Were we to estimate the average advantage to industry we may consider a reduction in average cost and emissions attributed to reduced generation of electricity by twelve percent. The 'cost of abatement' is negative as it is a benefit, since efficiency measures have negative cost (or are economic) over the life of the intervention.

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More efficient use of electricity avoids electricity generation, and hence there are reductions in local emissions from the power sector. Recall that we account for rebound effects, and these offset savings only slightly. Less than 5% of savings are lost to the rebound effect, due to increased economic activity due to the SD-PAMS scenario's negative cost nature.

System costs decline with more efficient use of industrial energy. These costs decrease over the scenario period, by about 8.3 billion Rand (discounted and about double that figure in nominal

[10] Of which approximately three hundred million, or 7%, is attributed to a reduction in fuel costs. Most of the savings are from avoided power station investment.

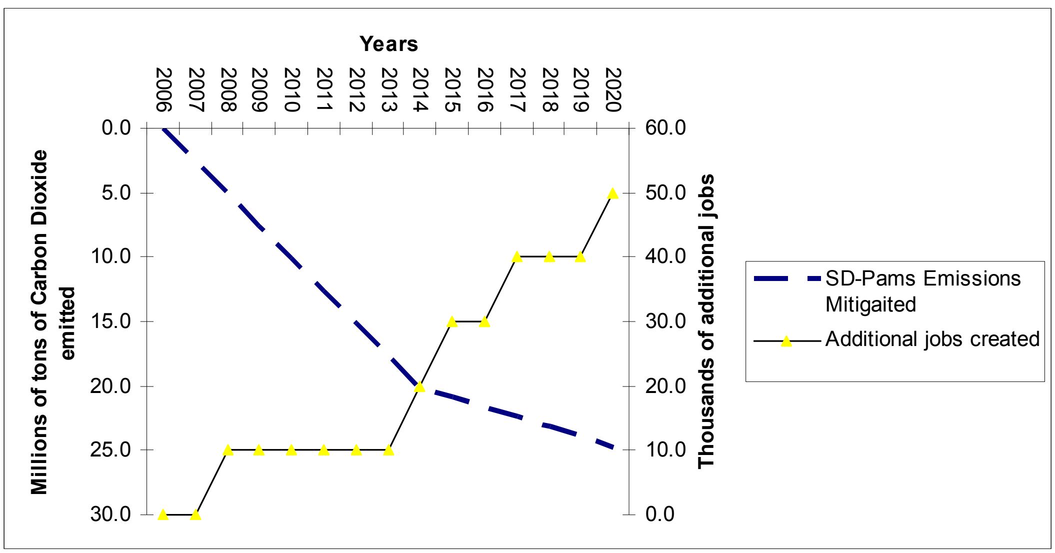
[11] Abatement costs increase between 2014 and 2020, since most of the savings are achieved early on in the period.

terms). The costs savings are due to two factors – (1) fuel savings in industry itself and (2) the postponement and reduction of new investment in the power sector. By the end of the scenario period approximately 4 GW of electricity generating capacity is displaced by energy efficiency measures. Coal-fired power stations investment is delayed by approximately three years. In the electricity plan, these large baseload stations would only be built around 2013, and with this SD-PAM would only be needed in 2016 or so.

During 2014, when the energy efficiency target is reached, significant in-roads have been made in terms of meeting the stated local development goals. About forty thousand new jobs are created, counting only those from electricity conservation within industry and not including potential savings that would accrue to other fuel use and to mining. The economy (and all fuel) wide effects of these measures are hundreds of thousand of jobs created. Four hundred million litres less water is used, two hundred thousand tons of SO_2 is mitigated, as are twenty three thousand tons of particulates, and eighty thousand tons of nitrogen oxides.

Co-benefits of this sustainable development measure include significant greenhouse gas mitigation. In Figure 2 we show the CO_2 savings relative to the reference case as well as the extra jobs created.

Figure 2: CO_2 savings by scenario and jobs created through SD-PAMs in industrial energy efficiency



Over the whole scenario period, there is a reduction of approximately 230 million tons of carbon dioxide at a net cost saving, giving a cost per ton of CO_2 of just less than zero dollars per ton.

4. Institutional and policy issues

4.1 Implications for sustainable development policy

The previous section has illustrated the potential benefits of sustainable development policies and measures. The case study of industrial energy efficiency shows that major benefits in the environmental, social and economic dimensions can be achieved. The results in Table 6 show that energy efficiency reduces the atmospheric emission of harmful substances such as oxides of sulphur, oxides of nitrogen, and particulates by approximately 4-6% compared to current development trends. This constitutes a significant contribution to a cleaner environment and healthier living conditions for local communities, in other words the environmental benefits have social ramifications as well.

The major social benefit of this SD-PAM lies in the additional jobs created. Some of the jobs are created directly in implementing energy efficiency programmes, but even more result from the indirect effects (most of which are due to the delayed construction of new power plant). Two major socio-economic benefits are that reduced electricity demand avoids (or delays) investment in new power stations, and that reduced levels of investment in electricity generation can be used for other development priorities.

This strategy has the potential to shift SA's competitive advantage from a traditional reliance on low-cost electricity (and hence energy-intensive products, such as gold mining, aluminium smelting and other products) to one that uses energy more efficiently. Part of such an industrial strategy would be a focus on export value-added products, which have with a lower energy- and emissions-intensity. Unlike approaches that use emissions intensity to set dynamic targets, however, the SD-PAMs approach focuses on the *actions* required to reduce this intensity. The strategy shows how the economy can derive greater value from efficient use of domestic energy resources.

In the SD-PAMs framework, reduction of GHG emissions is a co-benefit of policy driven by development objectives. The modeling results reported in Table 6 indicate that this co-benefit has the potential to reduce 5% of SA's total energy CO_2 emissions in the year 2020. These can be achieved at negative cost, with the interventions paying for themselves in a short period. If 25 $MtCO_2$ avoided in 2020 were sold at 2005 prices for CERs of \$5 / tCO_2 , this would generate carbon revenues of \$ 100 million. The carbon price is expected to increase over the period, so that this represents a conservative estimate.

4.2 International institutions

The number of proposals on future mitigation commitments has mushroomed since 2002, and a number of useful summaries are available.(Baumert et al. 2002; Bodansky et al. 2004; Höhne et al. 2004) Future actions to avoid dangerous climate change could take different forms, ranging from mandatory requirements, such as quantified emissions limitation targets, to pledges to make their development path more sustainable.

4.2.1 Global frameworks and pledge-based approaches

Dividing a global reduction target amongst all countries (in a 'top-down' manner) is only one possible approach. The alternative approach is pledge-based (in a 'bottom-up' matter). The pledge could be to quantified emissions targets, as in the Kyoto process, or more qualitative in nature. In such an approach, it is clear that countries negotiate in their self-interest, so each tends to propose indicators most beneficial to itself.(Grubb et al. 1999: 85) Extending the climate regime will probably require pledges by developing countries.

The SD-PAMs is a pledge-based approach to developing country participation in mitigating climate change. The approach focuses on implementing policies for sustainable development, rather than setting emissions targets. It recognises the political reality that climate change (and in some cases even environmental policy more broadly) are marginal issues for many developing countries, and lower in national priority than economic and development policies.(see, for example, Sokona et al. 1999; see, for example, Mwandosya 2000; Berk et al. 2001) It builds on existing commitments and the right to sustainable development enshrined in the Convention. The move towards sustainability would be driven primarily by local and national benefits – social, economic and environmental benefits to the country. Given the differences between developing countries (indigenous energy resources, population, GDP, emissions profiles, level of industrialisation, etc), the plans can be expected to differ significantly across countries.

4.2.2 Defining the pledge: Implement SD-PAMs

SD-PAMs would be defined by individual developing countries (Winkler et al., 2002).

The SD-PAMs pledge would be to implement and accelerate national sustainable development plans. The ‘commitment’ would not be measured directly in GHG emissions units, but rather in SD units – additional jobs created, or MW of generating capacity avoided (see last column of Table 6), rather than a specified reduction in tons of CO_2. Indirectly – as a co-benefit – SD-PAMs contribute to considerably lower emissions than current development trends. The detailed example in section 3 makes clear that these co-benefits are substantial in the case of industrial energy efficiency. Pledged SD-PAMs must be (1) government actions that have (2) development benefits and (3) GHG co-benefits (Baumert & Winkler forthcoming). The motivation for taking action, however, is to pursue sustainable development at the national level, and hence the pledge is framed in terms of action taken.

SD-PAMs would be defined by individual developing countries (Winkler et al. 2002a). “Policies and measures” is not a rigid concept, and could include fiscal policies (taxes, charges, subsidies), regulatory measures (mandates, standards, sector reforms), or other initiatives that have some official status (Baumert & Winkler forthcoming).

SD-PAMs commitments would initially be voluntary, although they could be made mandatory for at least some developing countries. The proposal of the South-North Dialogue was that SD-PAMs would be obligatory for Newly Industrialised Countries (NICs) and Rapidly Industiralising Development Countries (RIDCs); with NICs expected to carry these out with their own resources, while RIDCs would require a level of co-funding.

The SD-PAMs pledge builds on *existing* commitments of developing countries. Almost all developing countries are signatories to the Convention. Under Article 4.1(b), all Parties commit themselves to ‘formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases.’ This commitment is currently not quantified for developing countries in the same way as for industrialised countries listed in Annex B of the Kyoto Protocol. SD-PAMs as a pledge-to implement policies for sustainable development would be consistent with Article 10 of the Protocol, which re-affirms existing Convention commitments and aims to ‘advance the implementation of these commitments in order to achieve sustainable development’ UNFCCC 1997.

4.2.3 Building confidence through tracking and review

To formalise the approach, some need for reporting and oversight through the Climate Change Convention would be necessary. Building on the pledge discussed above, SD-PAMs could be tracked through an international registry, and their implementation would need to be reviewed. Reporting would assist in monitoring whether SD-PAMs are actually implemented, and this would require some institutional capacity in the pledging country (see section 4.2.6). At the same time, reporting can help to correct the mis-perception that developing countries are doing nothing on climate change. As outlined in section 2.2, the associated changes in GHG emissions are quantified.

While the SD-PAMs commitment would initially be voluntary, a simple reporting system should be established in order to formalise the commitment of those countries who pledge to implement SD-PAMs. National capacity to monitor, report and verify that targets are being met systems at the national level would be an important dimension of the national capacity to implement SD-PAMs. Section gives an example of existing capacity to measure and verify energy efficiency gains in SA industry.

At the international level, reviewing the pledges would require a decision of the Conference of the Parties to establish a registry of SD-PAMs. Rather than creating an entirely new institution, a special SD-PAMs reporting registry would be created within the existing framework of the UNFCCC.(Bodansky et al. 2004) Such a registry would record data based on regular reporting by Parties on their SD-PAMs, and support from the Secretariat for maintaining the records of implementation. The registry would serve as a tool to exchange information between governments, and between governments and civil society (Baumert & Winkler forthcoming). If voluntary reporting proves successful, a next step would be to make reporting of SD-PAMs mandatory for a group of middle-income developing countries. Some developing countries might view this as intergovernmental control over national policy making, which could present a political obstacle. However, there need be no prescribed list of SD-PAMs, leaving it to the country to define its own policies.

Reporting would primarily review progress assessed in the metric of the target – in our case study, in terms of the percentage energy saved through efficiency compared to an energy baseline. This could come in the form of an annual or other regular progress report. In other words, reporting would assist the joint assessment of pledged actions. Associated GHG abatement could also be reported, in order to change the perception of some Annex I countries that developing countries are not participating in climate protection. This reporting would be similar in spirit to Article 12.4 of the Convention,[12] where developing countries may voluntarily propose mitigation projects. The proposed reporting would extend to all SD-PAMs, including those that are not project-based. In order to assess progress against SD-PAMs pledges, a system of indicators for sustainable development could be adapted.[13]

Reporting of SD-PAMs could be included in national communications. This would have the advantage that the information would be addressed in the in-depth reviews. However, the process of national communications has become highly politicised, in particular around the provision of technical and financial resources. (See the language in UNFCCC (1992), Article 12.7.) Given that some developing countries are not submitting their initial national communications, it might be preferable to separate the register of SD-PAMs from this process. Separate reporting could be narrower in scope and less technically challenging and expensive to produce (Baumert & Winkler forthcoming). SD-PAMs reports could be reviewed through the established procedures for 'in-depth' reviews, using a facilitative approach.

In short, developing countries would formulate, implement and report on SD-PAMs. Reporting and international review seem consistent with a facilitative approach to compliance.

4.2.4 Mobilising investment in SD-PAMs

A key barrier to the implementation of SD-PAMs in developing countries is the lack of financial resources. Determining who pays for SD-PAMs is integrally related to the question of formalising the pledge in the manner suggested above. Countries are unlikely to fulfil pledges unless they have the resources for implementation. Under Article 4.3 of the Convention, developed country Parties are already committed to paying 'full agreed incremental costs' of

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12 Article 12 deals with national communications and paragraph 4 reads: 'Developing country Parties may, on a voluntary basis, propose projects for financing, including specific technologies, materials, equipment, techniques or practices that would be needed to implement such projects, along with, if possible, an estimate of all incremental costs, of the reductions of emissions and increments of removals of greenhouse gases, as well as an estimate of the consequent benefits.'

13 Existing work on indicators for sustainable development in the climate change context includes guidelines and methods developed by the Commission on Sustainable Development (CSD 1995). There is also an on-going process in the FCCC negotiations on 'good practices' in policies and measures. For the energy sector, the Helio network has developed and applied sustainable energy indicators (Helio International 2000). A practical method applied to CDM projects (Thorne & La Rovere 1999) could potentially be extended to use at the national level. Chapter 1 of the IPCC's Working Group III Third Assessment Report summarises the broader debate on sustainable development and climate change, while chapter 10 focuses on decision analytical frameworks (IPCC 2001).

activities under Article 4.1. The commitment to funding is repeated in Article 11 of the Protocol. If SD-PAMs are adopted under Article 4.1b, the question of payment should in principle be decided already. Domestic funding will still be needed for 'ordinary' development costs.

SD-PAMs funded purely domestically would constitute a *single country* pledge (analogous to unilateral CDM). A country may wish to register a SD-PAM that is unique to its national circumstances and achieve international recognition of this contribution to the global effort to combat climate change.

A second approach would be *mutual pledges*, which would involve simultaneous pledges by both a developing and developed country. Here, the approached envisioned in Article 4 of the UNFCCC would be operationalized. A developing country Party would pledge to undertake a particular PAM, and one or more industrialized country would agree to assist in technology transfer or funding support.

The challenge is to ensure that funds actually flow from Annex I countries to meet the *incremental* costs.

However, even if agreement can be reached on the 'full agreed incremental costs', the "non-incremental" costs need to be met. A number of funding sources can be considered, including overseas development aid (ODA) and domestic sources. Since SD-PAMs implement national development objectives, significant amounts of domestic funding should be mobilised for the non-incremental costs. The case study in section 3 shows national savings over the period of investment. While upfront programme costs need to be met, there is an incentive to finance negative-cost SD-PAMs. Other examples, such as renewable energy technologies, would have a more distinct incremental component.

SD-PAMs with GHG reduction potential could in addition receive climate change-related incremental funding, including investment through the Clean Development Mechanism (CDM), climate change funds through the Global Environmental Facility (GEF), and the funds established at Marrakech under the Convention (Special Climate Change Fund, LDC fund) and Protocol (Adaptation Fund). Some of these funds would be most suited to projects (CDM), others to enabling activities (GEF) or policy changes (e.g. under sectoral CDM).

4.2.5 Links to CDM and emissions trading

Being national in character, the SD-PAMs approach does not have links to international emissions trading. Unless the emissions reductions associated with SD-PAMs were quantified quite accurately, the 'cap' required for emissions trading would not be adequately specified. However, SD-PAMs that reduce GHG emissions are likely to be good candidates for investment under the Clean Development Mechanism (CDM.) The CDM requires that projects reduce emissions and promote the sustainable development objectives of the host country, implying a clear synergy with the SD-PAMs approach. Through the CDM and the certified emission reductions generated, developing countries would have some link to the emerging market for carbon credits. SD-PAMs with quantified emission reductions are similar in concept to other approaches, notably 'policy' or 'sector CDM'(Samaniego & Figueres 2002; Bosi & Ellis 2005) and action targets (Goldberg & Baumert 2004; Baumert & Goldberg forthcoming). However, the SD-PAMs approach would be broader in scope, including emissions reduction due to policies (such as changes in prices of energy) that could not qualify as CDM projects, which tend to focus on investment in technologies, infrastructure or programmes.

CDM investment is linked to projects and therefore unlikely to fund policy changes, such as energy policy reforms, industrial policy or sector-wide strategies. Yet such policy changes may well be critical to limiting GHG emissions. Providing funding for policies and measures would be a major incentive for developing countries to take action on climate change.

While the CDM formally includes sustainable development as a second objective, the emerging CDM project portfolio is shaped almost exclusively by financial incentives for the emission-reduction component of projects.(CDM Watch 2004) The exceptions come from a small number of investors that wish to pay a premium for particularly SD-friendly CDM projects.(Gold Standard 2005) As a result, many of the projects identified in the current project portfolio represent relatively low-cost emission mitigation opportunities that result from "tweaking" existing technologies and processes and identifying and eliminating out unnecessary waste, as opposed to the investment in new infrastructure and technology. Some proposed projects also have low sustainable development benefits.(Ellis et al. 2004)

SD-PAMs seeks to ensure that a mechanism in a future climate regime will exploit the potential link between local sustainable development benefits and mitigation more effectively. The financial incentives need to be attached not only to GHG emission reductions, but also to local sustainable development benefits. The benefits would be more lasting, if embodied in changes in energy infrastructure and long-term changes in other sectors, e.g. improved farm management practices.

4.2.6 SD-PAMs and generic architectural elements

To integrate SD-PAMs within the multi-lateral climate change regime under the UNFCCC and the Kyoto Protocol, it is useful to examine architectural elements that any approach to future climate action. Some of the elements proposed in (Baumert et al. 2002)are reflected in Table 7, together with two assessments of the SD-PAMs approach – one done as part of the review for the Pew Centre of a range of approaches (Bodansky et al. 2004)as well as our own assessment.

Table 7: SD-PAMs and architectural elements

Source: Columns 1 and 2 follow Baumert,(2002) column 3 assessed in Bodansky,(2004) and column 4 own assessment

Architectural element	*Options*	*SD-PAMs, assessed by Bodansky*	*SD-PAMs, based on this case study*
Approach	Pledge-based / bottom-up; or Principle-based / top-down		Pledge-based
Legal nature of commitment	Legally binding or non-binding		Initially non-binding, but subject to review Could become mandatory for some groups of countries
Financial commitments	Funding for adaptation, RE investment, SD-PAMs, technology transfer, etc Compensation for climate impacts	Funded under existing UNFCCC and KP provisions, including CDM	Annex II meets existing commitments to finance full agreed incremental costs in NAI countries that pledge SD-PAMs
Type of GHG limitation commitment	Carbon tax Harmonised PAMs Fixed targets (Kyoto-style) Emissions intensity (per GDP, dual) Safety-valve SD-PAMs	SD-PAMs: Implementing and accelerating development plans No GHG targets for DCs	Pledge to implement SD-PAMs
Accountability commitments	Non-compliance consequences		Review process

	Measurement, reporting, review		
Approach to differentiating GHG commitments	Pledge-based / principle-based	Implicit differentiation between AI (with mandatory GHG targets) and NAI (with SD0PAMs)	Pledge-based
Use of market mechanisms	Project –based / int'l emissions trading		Beyond physical project, see section 4.2.5
Timing and triggers	2nd commitment period Medium-term Long-term Graduation	Proposed as useful interim step towards deeper developing country participation Suggests 'midd'e-income' might transition to mandatory SD-PAMs	Short-term (including 2nd commitment period of KP)
Environmental objective	Article 2 Keep stabilisation options open Limit on global emissions or temperature increase		Framed in terms of *local* SD objectives, including environmental; probably most consistent with keeping options open

SD-PAMs is clearly a pledge-based approach, which at least initially would be voluntary. The review process and national M&V programmes could, however, increase the confidence that implementation takes place and makes a difference. SD-PAMs extend the current architecture of the CDM to include policies that do not have easily-defined project boundaries. While domestic financing can play an important role in SD-PAMs, the approach does need to be part of a package that includes international financing for climate-friendly development as well.

SD-PAMs is an approach that could operated in combination with a range of other approaches. It focuses on the actions that developing countries would take in the sphere of local sustainable development. It could form part of a package of enabling measures, together with technology transfer and finance. In and of itself, SD-PAMs sets no climate target. It focuses on the actions required to reduce emissions. As part of a package of measures, SD-PAMs can assist in meeting targets set by other approaches, e.g. growth caps or sectoral intensity targets.

4.3 National-level capacity

Institutional capacity at the national level will be critical to implement SD-PAMs. Institutional arrangements clearly vary dramatically across developing countries. In this section, we continue the case study of South Africa.

There is no central Ministry or department solely responsible for development in South Africa. While the Department of Environmental Affairs & Tourism would be the focal point for issues of sustainable development, many other departments deal with the issue in relation to their line function. For industrial energy efficiency, key energy industries, such as the electric utility Eskom, the synfuel company SASOL and other industry sectors (chemicals, mining), would need to be centrally involved in implementing any SD-PAMs.

The confidence in SD-PAMs as an instrument can be increased if there is confidence that the targets set are achieved in practice. Taking the case study of energy efficiency, how would the international community know that the reported savings have really occurred? Much of this depends on the institutional capacity in the country. In the case of South Africa, institutional infrastructure already exists to measure and verify the implementation of energy efficiency interventions in industry.

Figure 3: Institutions involved in measuring and verifying energy efficiency savings in South Africa

Source: (Grobler & den Heijer 2004)

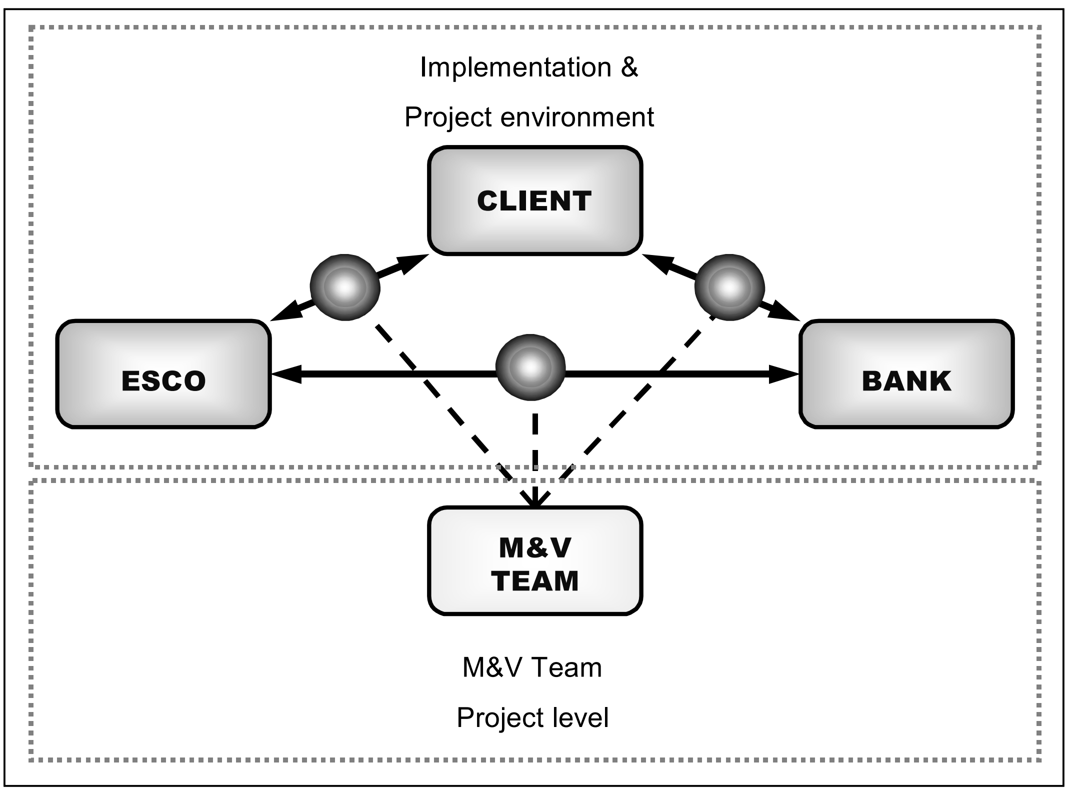

Figure 3 shows that several institutions are involved in measuring and verifying energy savings. Eskom, the electric utility, has a demand-side management programme. The implementation of the programme is outsourced to energy service companies (ESCOs), who assist clients in industry, commerce and residential sectors. The ESCOs carry out specific interventions for companies in industry (the clients in Figure 3), many of which are of the kind described in 3.

Four universities in South Africa are involved in measurement and verification (M&V) teams. These teams are employed by the utility to measure the savings, against an energy baseline established prior to the intervention. After the intervention, the teams measure energy consumption by once-off use of instrumentation, or long-term data recording. A conservative approach to energy savings is taken by the M&V teams, who only report energy savings that can be verified. Reports on the verified savings are submitted to the National Electricity Regulator (not shown in the figure) as well as the client.

The implication is that institutional capacity to measure and verify SD-PAMs in energy efficiency already exists. In the case of energy efficiency in South Africa, reporting requirements on an energy-efficiency pledge could build on existing M&V system. The international community might want to supplement this system, but does not need to start from scratch.

5. Conclusion

The SD-PAMs approach starts from development objectives and searching for ways to make development more sustainable. The case study in this paper illustrates that if countries begin to act early to move to greater sustainability, they will also start to bend the curve of their emissions path. The benefits of industrial energy efficiency in South Africa include significant reductions in local air pollutants (oxides of sulphur, oxides of nitrogen, and particulates by approximately 4-6%); improved environmental health; creation of additional jobs; reduced electricity demand and delays in investments in electricity generation; and the creation of new competitive advantages through more efficient production. The co-benefit of reducing GHG emissions is substantial at 5% of SA's total energy CO_2 emissions in 2020 and could generate significant carbon revenues. The challenge of financing SD-PAMs in this case could at least partly be addressed through existing mechanisms such as the CDM.

However, the paper explores a broader range of financing options, including the GEF and the funds its operates, as well as domestic, bi- and multi-lateral development funding. Institutional capacity to implement SD-PAMs is critical both at the international and national levels. We propose that a system of pledge, report and review could be established under the UNFCCC. Continuing the case study, national capacity to measure and verify energy savings – which exists in the SA case – can provide a firm basis.

SD-PAMs has the potential to extending the set of policies considered for mitigation beyond the traditional climate policies to development policies. A country would only pick SD-PAMs that make sense in local development terms. However, many such policies are not implemented, not least due to lack of finance. Financing from Annex II parties, based on existing commitments, can support the implementation of such policies. The SD-PAMs approach would assist by quantifying the GHG implications of development policies.

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ENDNOTES:

[1] Job creation effects related to energy efficiency investments have been described (Jeftha 2003; Laitner et al 1998; Geller et al. 1992), and specifically for South Africa (Laitner 2001; Hughes et al. 2002; Spalding-Fletcher et al. 2003; Howells and Laitner 2005). We adopt and adapt a demand input-output analysis, as per Howells and Laitner (2005), and determine economy-wide expenditure changes on labour due to the changes in purchasing per unit of energy saved for an energy efficiency measure, and per unit of capacity invested in for a new power station. We go further to simplify this for entry into the energy systems model, into economy-wide job creation during an "investment year" and during the "operational life" of the measure (summarized in the table below). To construct the I/O model, a series of assumptions were made, which allow us to relate the payback period and the life of the measure to the net job-creation figures sought. In the case of an energy efficiency measure, we assume industry will pay for the implementation of the measure. We assume that 50% of this expenditure is financed internally and the rest from debt, to be repaid over five years. Depending on the local South African content of the measure, the money is spent locally and recycles, or leaves the economy (Spalding-Flecher et al. 2001). After the measure is implemented, industry in turn receives savings, and reallocates this spending, we assume, as per its usual pattern of expenditure. In the case of the power station, we assume the investment to be 60% debt financed (NER 2004) repaid over the economic life of the plant. We also only consider the cost of the capital requirements for the new power plant, as this will be the only "change" to be accounted for from the current SAM. For each change in purchases, whether as a loan from the financial sector, expenditure on construction for a new measure or power plant, or re-allocated funds from energy savings, we determine the

direct and indirect effects that result for each economic sector. We can thus derive the changes in requirements for labour and energy costs.

Measure	*Thermal saving*	*Other thermal measures*	*Efficient motors*	*VSDs*	*Efficient lighting*	*Compressed air saving*	*HVAC*	*Refrigeration*
Local content	80%	80%	80%	80%	80%	80%	80%	80%
Job-creation per PJ saved (operation)	88	105	-137	-83	-81	76	5	53
Job-creation per PJ saved (investment)	201	95	3246	2571	1680	324	973	568
Local content	20%	20%	20%	20%	20%	20%	20%	20%
Job-creation per PJ saved (operation)	103	97	-60	-22	-44	68	17	78
Job-creation per PJ saved (investment)	-199	-193	-893	-740	-528	-259	-398	-268