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Sustainable development policies and measures: institutional issues and electrical efficiency in South Africa

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An innovative approach is introduced for helping developing countries to make their development more sustainable, and also to reduce greenhouse gas (GHG) emissions as a co-benefit. Such an approach is proposed as part of the multilateral framework on climate change. The concept of sustainable development policies and measures (SD-PAMs) is outlined, making clear that it is distinct from many other approaches in starting from development rather than explicit climate targets. The potential of SD-PAMs is illustrated with a case-study of energy efficiency in South Africa, drawing on energy modelling for the use of electricity in industry. The results show multiple benefits both for local sustainable development and for mitigating global climate change. The benefits of industrial energy efficiency in South Africa include significant reductions in local air pollutants; improved environmental health; creation of additional jobs; reduced electricity demand; and delays in new investments in electricity generation. The co-benefit of reducing GHG emissions could result in a reduction of as much as 5% of SA's total projected energy CO_2 emissions by 2020. Institutional support and policy guidance is needed at both the international and national level to realize the potential of SD-PAMs. This analysis demonstrates that if countries begin to act early to move towards greater sustainability, they will also start to bend the curve of their emissions path.

Keywords: sustainable development; public policies; policy instruments; developing countries; energy efficiency; South Africa; mitigation; economic development

Une nouvelle approche au développement durable est proposée pour les pays en développement qui leur permettrait aussi de réduire leurs émissions de gaz à effet de serre. Cette approche est proposée au sein du cadre multilatéral des politiques climatiques. En ayant comme point de départ le développement, et non un objectif climatique défini, le concept de politiques et mesures de développement durable (PM-DD) se distingue clairement de beaucoup d'autres approches. Le potentiel des PM-DD est illustré en s'appuyant sur une étude de cas d'efficacité énergétique en Afrique du sud, où la consommation d'énergie du secteur industriel est calculée. Les résultats sont positifs autant pour le développement durable local que pour la limitation des changements climatiques. L'efficacité énergétique en Afrique du sud donne lieu à une réduction considérable de la pollution atmosphérique locale , l'amélioration de la santé environnementale , la création d'emplois , la réduction de la demande en électricité, et un décalage temporel sur la nécessité des investissements de production énergétique. Les avantages environnementaux associés à la réduction de GES pourraient être aussi élevés que 5% des émissions totales en CO_2 du secteur énergétique sud-africain. Un soutien institutionnel et des directions politiques claires sont souhaitables aux niveaux national et international pour mettre en œuvre le potentiel des PM-DD. L'analyse présentée illustre que si les pays se mettent à agir tôt en matière de développement durable, leur niveau d'émissions peut commencer à baisser de façon notable.

Mots clés: Développement durable; politiques nationales; instruments politiques; pays en développement; Afrique du Sud; mitigation, développement économique

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1. Introduction

Climate change is a global problem requiring the cooperation of all countries in order to be addressed effectively. This article 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. This approach has a basis in the Convention, which, together with a proposed reporting structure, would provide sufficient stringency for a first step.

The next section outlines the SD-PAMs approach in concept, and specifies the practical steps that 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 electricity savings, local environmental benefits (air pollution and water), job creation potential, as well as the co-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 realized in the UNFCCC system and what national capacity is needed – and already exists – to implement SD-PAMs.

2. The SD-PAMs approach

The SD-PAMs approach starts with the development objectives and needs of developing countries.[1] 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 in greenhouse gas (GHG) emissions.

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, and 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 article, 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 to meet growing needs, such as building houses, feeding people or lighting and heating households. 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).

In the climate negotiations under the UNFCCC, the importance of sustainable development has long been recognized. Article 3.4 of the Convention (UNFCCC, 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.

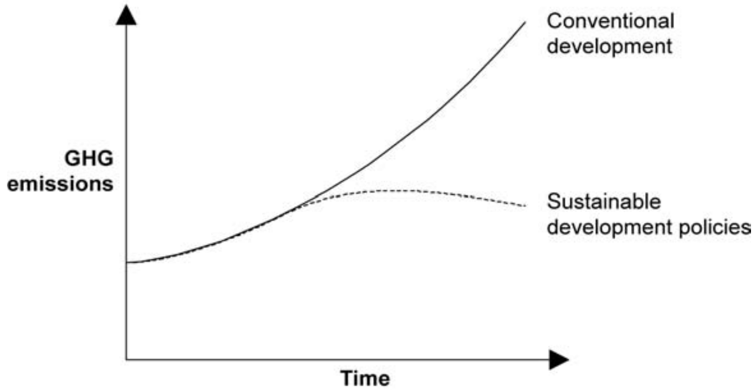

FIGURE 1 Hypothesis that SD-PAMs will reduce emissions below BAU.

The SD-PAMs pledge builds on the *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 operationalized for developing countries in the same way as for industrialized 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).

Among climate scientists, IPCC 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 and Weyant, 2001). The challenge considered in this article is to turn the conceptual link between sustainable development and climate change into a workable approach.

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, where possible quantifying the expected benefits and possible risks.[2] If a long-term vision has been articulated, back-casting to immediate action is possible. Otherwise, shorter-term goals may be outlined.
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 either (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. Mobilize investment and implement SD-PAMs.

5. Set up national monitoring systems to track implementation of SD-PAMs.
6. Conduct a review of SD-PAMs in SD units, either as part of national communication or as 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. Summarize 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 are able to 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 4.3).

3. Using electricity efficiently in South African industry

The South African government has outlined an energy efficiency strategy, setting a goal for an improvement in energy efficiency of 12% by 2014 relative to projected consumption (DME, 2005). The strategy is explicitly motivated by a concern for the three dimensions of sustainable development – economic, social and environmental (DME, 2005). The efficient use of electricity in South African industry can promote local development goals.

3.1. Brief review of government energy efficiency strategy

The strategy aims to improve social sustainability by improving health through reductions in local air pollutants; by creating jobs in the implementation of energy efficiency measures; and by contributing to poverty alleviation by reducing electricity bills for poorer households. From an environmental perspective, both local air pollutants (such as sulphur dioxide, oxides of nitrogen and particulates) and global greenhouse gases are reduced. Economic sustainability can be enhanced by energy efficiency, with improved competitiveness through reduced costs; enhanced energy security by saving on imported fuels; and delaying the building of the next generation of power stations (DME, 2005). Specific measures were outlined to achieve these multiple goals.

For electricity specifically,[3] to achieve the DME target of 12% saving over a business-as-usual scenario, the following measures were considered:

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.

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 (Hughes et al., 2003).

In the following section, describing a national energy model,[4] we consider a range of interventions in the manufacturing industry to promote greater energy efficiency.[5] We consider the effects of meeting government energy efficiency targets, compared to a baseline scenario. The section concludes with an analysis of the implications of energy efficiency policies on sustainable development goals.

3.2. National energy model

We build on previous work which determines the level of energy saved by a 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 and Laitner, 2005).

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.[6] A full description of the model used is contained in Howells (2004).

We calibrate the model using detailed sector-by-sector demand projections (Howells, 2004) 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 correlate energy use with the attribute considered. We assume that significant fuel switching is limited over the scenario period (DME, 2005). Gaseous emissions per unit of fuel consumed are taken from IPCC (1996) and 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 and Laitner, 2005).

We further develop the standard formulation of this model to incorporate rebound effects. Sector-specific rebound effects are included by adopting a non-standard model structure (Howells, 2004).

3.2.2. Reference case

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 more efficient use of electricity is implemented as a SD-PAM. The differences in results between the two scenarios show the impacts that energy efficiency can have on local sustainable development, and on emission reductions.

The reference case is a business-as-usual (BAU) 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). The 'primary planning assumptions' are a net discount rate of 10%; an average medium-term economic growth rate of 2.8%; a low penetration of demand-side management measures; and that the energy-intensive structure of the economy persists. These assumptions are consistent with the previous integrated energy planning exercises of the Department of Minerals and Energy (DME, 2003). The model is run over the period from 2005 to 2020.

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

3.2.3. Policy scenario

The policy scenario includes energy efficiency measures implemented to meet the DME's energy efficiency target for industry. The specific SD-PAMs we consider are described by Howells and Laitner (2003) and Trikam (2002). Assumptions relating to the characteristics of these options, including aspects such as their economics, job creation potential, rebound effects and cost differences associated with local content are described by Howells and Laitner (2005). A short description of some 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.[7]
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 savings accruing to each measure is summarized in Table 1, adapted from Hughes et al. (2003). We compute the effects of this scenario and compare these to the base case, so that the savings are percentages of energy saved compared with the business-as-usual energy demand.

The quantity of electricity saved differs by sector, as seen in the approximate electrical energy savings by industry shown in Table 2.

3.2.4. Results: sustainable development benefits and GHG co-benefits

The effects on the energy system are shown by comparing the SD-PAMs to the reference case. Since the SD-PAMs approach 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

TABLE 1 Savings by measure for the policy scenario

Technical electrical efficiency saving measure							
Steam systems	Other thermal measures	Efficient motors	Variable speed drives	Efficient lighting	Compressed air management	Heating, ventilation and cooling	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%

Source: adapted from Hughes et al. (2003).

TABLE 2 Percentage of electricity saving by industrial subsector

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

Source: adapted from Howells and Laitner (2005) and Howells (2006).

system, including power station investment, fuel savings, savings in transmission and distribution costs, and the investment costs of the energy efficiency measures. If the energy savings were compared only with industrial energy consumption, they would be approximately 5% both in 2014 and 2020. The particular measures generating savings of electricity are shown in Table 3.

Job creation effects related to energy efficiency investments have been described (Geller et al., 1992; Laitner et al., 1998; Jeftha, 2003), and specifically for South Africa (Laitner et al., 2001; Spalding-Fecher et al., 2003; Howells, 2004). We adopt and adapt a demand input–output analysis, as per Howells (2004), 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. Net jobs are calculated through the economy, and this can be introduced within MARKAL by adding the job gains and losses through the 'operation life' and initial 'investment' in energy efficient technologies in question. For further discussion of the methodology for calculating employment effects, see the Appendix.

Figure 2 shows the increase in jobs that result from an energy efficiency measure investment in 2006 which reduces coal consumption.

More efficient use of electricity avoids electricity generation, and hence there are reductions in local emissions from the power sector. Recall that we have accounted for rebound effects, and

TABLE 3 Electricity saving by measure

Measure	Percentage of total electricity savings	Ranking
Compressed air management	26%	1
Variable speed drives	18%	2
Efficient motors	17%	3
Efficient lighting	12%	4
Load shifting	9%	5
Heating, ventilation and cooling	6%	6
Other thermal measures	6%	7
Refrigeration	4%	8
Steam systems	1%	9

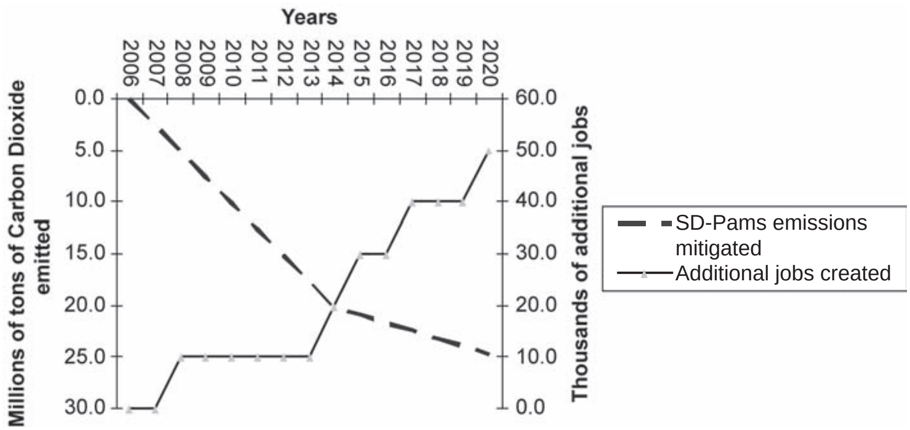

FIGURE 2 CO_2 savings by scenario and jobs created through SD-PAMs in industrial energy efficiency.

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 R8.3 billion (approx. US$1.1 billion at 2006 exchange rates) (discounted and about double that figure in nominal terms). The cost savings are due to two factors – firstly, the fuel savings in industry itself and, secondly, the postponement and reduction of new investment in the power sector. By the end of the scenario period, approximately 4,000 MW of electricity-generating capacity is displaced by energy efficiency measures. Coal-fired power stations investment is delayed by approximately 3 years. In the reference case, these large base-load stations would only be built around 2013, and with this SD-PAM would only be needed by 2016 or so.

During 2014, when the energy efficiency target is reached, significant inroads have been made in terms of meeting the stated local development goals. About 40,000 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 thousands of jobs created. In addition, 400 million litres less water is used, 200,000 tons of SO_2 is mitigated, as are 23,000 tons of particulates, and 80,000 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.

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 slightly less than zero dollars per ton.

3.3. Implications for sustainable development policy

The previous section 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 4 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 with 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.

TABLE 4 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[a]($0.55)	est. 8%	1.2($0.16)	est. 2%	Billion rand (US$ bn[b] in brackets)
Avoided investment in power stations	3,600	est. 7%	4,400	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[c]		$/$tCO_2$-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 12%. 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.
[a] Of which approximately 300 million, or 7%, is attributed to a reduction in fuel costs. Most of the savings are from avoided power station investment.
[b] Assuming an exchange rate of R7.50 = US$1.
[c] Abatement costs increase between 2014 and 2020, since most of the savings are achieved early on in the period.

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 of increased expenditure elsewhere. One example of an indirect effect is the delayed construction of new power plants, since the employment multipliers in industry are generally greater than for mining. Analysis of input–output tables, i.e. based on national accounts, shows that economy-wide, for every million rand invested, construction creates 25 job-years, mining 21 and manufacturing 19, all higher than electricity at 16 job-years per million rand. These effects have been analysed in more detail elsewhere (Spalding-Fecher et al., 2003; Howells, 2007; Howells 2004), but serve to indicate that the two major socio-economic benefits of reduced electricity demand are to avoid (or delay) investment in new power stations, and that of freeing up resources to invest in 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 electricity more efficiently. Part of such an industrial strategy would be a focus on export value-added products, which have 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 the 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 modelling results reported in Table 4 indicate that this co-benefit has the potential to reduce 5% of SA's total projected energy CO_2 emissions in the year 2020. These can be achieved at negative cost, with the interventions paying for themselves within a short period.

The case-study illustrates that SD-PAMs can be implemented in South African industry – with large local sustainable development benefits, and significant GHG reduction co-benefits. What needs to be done to give recognition to such an effort in the international climate change architecture?

4. Institutional and policy issues

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. SD-PAMs is a pledge-based approach to developing-country participation in mitigating climate change. In and of itself, the SD-PAMs approach sets no climate target. It focuses on the actions required to reduce emissions. Such actions very often are part of the sustainable development plans of countries, and hence this approach may well be attractive to developing countries.

This approach could operate in combination with a range of other approaches. The number of proposals on future mitigation commitments has mushroomed since 2002, and several useful summaries are available (Baumert et al., 2002; Bodansky et al., 2004; Höhne et al., 2004).

4.1. Defining the pledge: implementing SD-PAMs

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 4), 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 it 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 and Winkler, 2005). 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 and Winkler, 2005).

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 industrialized countries (NICs) and rapidly industrializing developing countries (RIDCs); with NICs expected to carry these out with their own resources, while RIDCs would require a level of co-funding.

4.2. Building confidence through tracking and review

To formalize 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 4.3). At the same time, reporting can help to correct the misperception that developing countries are doing nothing on climate change. As outlined in Section 2.2, the associated changes in GHG emissions are quantifiable.

Formalizing the pledged commitment could take two possible forms:

- The initial register could simply be a list of countries that wish to record their existing contribution through sustainable development and pledge further implementation. This could be recorded, for example, in a new Annex to the Convention. It has the advantage of simplicity.
- Another option would be a register of pledged policies and programmes. This approach has the advantage of specifying in more detail the actions to which countries are committing. However, reporting in common SD units may pose some political and methodological challenges.

The two approaches are not mutually exclusive – there could be an initial list of countries, with a register of SD-PAMs maintained, for example, by the Secretariat. The register could be established through a decision of the Conference of the Parties to establish a registry of SD-PAMs. It would serve as a tool to exchange information between governments, and between governments and civil society (Baumert and Winkler, 2005).

An important part of building confidence in the ability of SD-PAMs to deliver on its potential would be regular reporting. Again, the Convention offers the means of doing so in specifying that developing countries:

> 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 (Article 12.4).

The choice of identifying SD-PAMs would lie with the pledging country, avoiding lists of prescribed policies.

Regular reporting on such projects and policies could either (a) be part of national communications, or (b) a separate reporting mechanism could be established. Primary reporting should include reporting in 'SD units', e.g. the number of efficient low-cost houses built. This does not imply the need for harmonized indicators of sustainable development, only that there is some quantitative assessment of the local sustainable development benefits. In addition, the GHG co-benefits should be quantified, as illustrated in the methodological approaches above. Drawing on existing national capacity, means of monitoring the implementation of SD-PAMs could be established.

Reporting would begin by reviewing progress in the metric of the target – in our case-study, this would be measured in terms of the percentage energy saved through efficiency compared with 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. Reporting would go on to quantify the associated GHG abatement as a co-benefit, since it is a report to the Climate Convention. Reporting the GHG co-benefits of SD-PAMs could help to change the perception of some Annex-I countries that developing countries are not participating meaningfully in climate protection. This reporting would be similar in spirit to Article 12.4 of the Convention,[8] 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.[9]

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

4.3. National-level capacity

Institutional capacity at the national level will be critical to implementing SD-PAMs. Institutional arrangements clearly vary considerably 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 and Tourism would be the focal point for issues of sustainable development, many other departments deal with the issue in relation to their core 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, the institutional infrastructure already exists to measure and verify the implementation of energy efficiency interventions in industry.

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

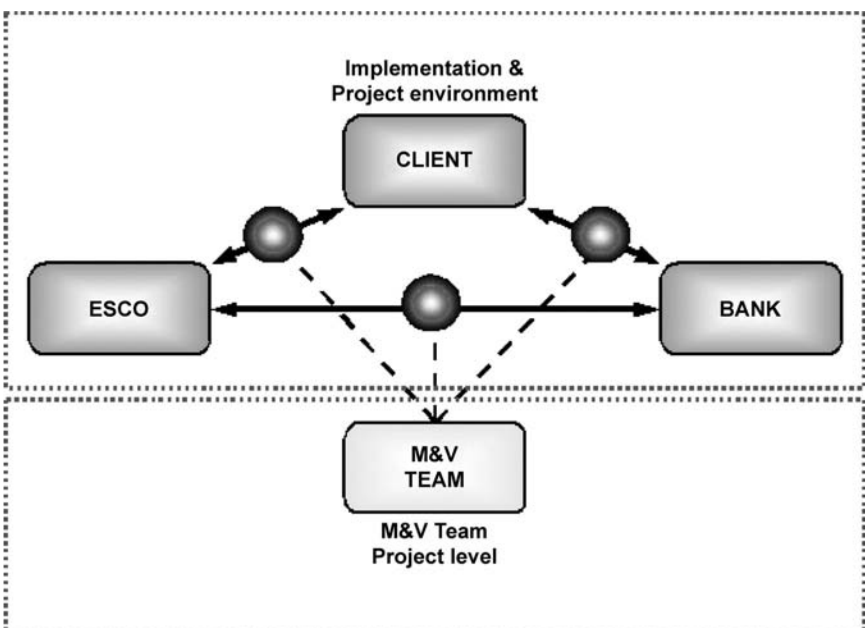

FIGURE 3 Institutions involved in measuring and verifying energy efficiency savings in South Africa.

Source: Grobler and den Heijer (2004).

companies in industry (the client in Figure 3), many of which are of the kind described in Section 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 either by a one-off use of instrumentation, or by long-term data recording. A conservative approach to energy saving 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 Figure 3) 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 the existing M&V system. The international community might want to supplement this system, but does not need to start from scratch.

4.4. Mobilizing investment in SD-PAMs

SD-PAMs of the scale needed to change emissions and development trajectories will require higher levels of funding than have hitherto been available for mitigation in developing countries (Bradley and Pershing, 2005). The present model for funding mitigation in developing countries has had only limited success. In principle, under Article 4.3 of the Convention, developed-country Parties are already committed to paying 'full agreed incremental costs' of activities under Article 4.1. Financial resources can be provided through the global environment facility (GEF) or through bilateral, regional or multilateral channels. This system, however, has no definitions, guidelines or requirements as to what measures developing countries might take, nor does it establish a systematic accounting of the funding provided (aside from the GEF), or of the resulting emission reductions. In practice, lack of financial resources remains a key barrier to the implementation of SD-PAMs in developing countries.

To achieve the Convention objective, the present system will need to improve. Whether SD-PAMs will deliver such an improvement cannot be known in advance. The approach does, however, offer more *rigour* and *flexibility* than the present system (Bradley and Pershing, 2005). It is more *rigorous* in that it establishes tangible commitments toward which financial resources can meaningfully be directed. It is more *flexible* in that climate change funding need not be so separated from non-climate funding. The real challenge is to instil carbon considerations into the broader set of international capital flows, only some of which are climate-specific.

The financing of SD-PAMs could draw on both climate and development funding. SD-PAMs funding should be able to come from any source: bilateral aid agencies, the GEF, multilateral development banks, export credit agencies, the private sector, the domestic sources, state and local communities, or others. Some funders – host governments, development banks and aid agencies – would be primarily concerned with alleviating poverty or otherwise boosting economic development. Since SD-PAMs implement national development objectives, significant amounts of domestic funding should be mobilized for the non-incremental costs. Other funders, such as the GEF, would invest because of the explicit climate benefit. Still others, such as private banks or corporations, would have commercial purposes, or would finance the GHG component of a policy or project in order to acquire the resulting emission reductions.

The intent is to align and strengthen the potential link between sustainable development and mitigation – also in financing. To this end, the relevant financial institutions need to be mobilized in a manner that maximizes resource and technology flows to development initiatives that deliver climate benefits. The benefits would be more lasting if they were embodied in changes in energy infrastructure and long-term changes in other sectors, e.g. improved farm management practices.

5. Conclusions

The SD-PAMs approach starts from development objectives and searching for ways to make development more sustainable. The case-study presented in this article 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; the creation of additional jobs; reduced electricity demand; delays in new investment 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 projected energy CO_2 emissions by 2020.

However, the article explores a broader range of financing options, including the GEF and the funds it operates, as well as domestic, bi- and multilateral development funding. The 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, the national capacity to measure and verify energy savings – which already exists in the case of SA – can provide a firm basis for quantifying the benefits of SD-PAMs.

SD-PAMs have the potential to extend 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 a lack of finance. Financing from Annex-II parties, based on existing commitments, can support the implementation of such policies. The SD-PAMs approach could assist by quantifying the GHG implications of development policies.

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Notes

1. This section of the article draws on the SD-PAMs concept as described in earlier work, notably by Winkler et al. (2002a, 2002b).
2. 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.
3. In addition to the DME strategy, there is an existing 'energy efficiency and demand side management policy', for efficiency in the electricity sector in particular (NER, 2003).
4. The work described in Sections 3.1 and 3.2, including the modelling and policy analysis, is part of the research undertaken by Mark Howells at the University of Cape Town's Energy Research Centre in partial fulfilment of a PhD.
5. 'Industry' here does not include the mining sector, where additional benefits are possible.
6. ETSAP (Energy Technology Systems Analysis Program), 2005 (see http://www.etsap.org/index.asp).
7. Rotor losses, a form of power losses, are also called slip losses because they are largely – but not entirely – dependent on the degree of slip the motor displays. Slip is the difference in rpm between the rotational speed of the magnetic field and the actual rpm of the rotor and shaft at a given load. As rotor losses are often reduced in more efficient motors, their speed is increased.
8. 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.

9. 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) and, more recently, through a multi-agency report (IAEA et al., 2005). There is also an ongoing 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 and 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 summarizes the broader debate on sustainable development and climate change, while Chapter 10 focuses on decision analytical frameworks (IPCC, 2001).

References

Banuri, T., Weyant, J.P., 2001. 'Setting the stage: climate change and sustainable development', in: B. Metz, O. Davidson, R. Swart and J. Pan (eds), *Climate Change 2001: Mitigation. Contribution of Working Group III to the Third Assessment Report of the IPCC*, Cambridge University Press, Cambridge, UK, 74–114.

Baumert, K., Blanchard, O., Llosa, S., Perkaus, J.F. (eds), 2002, 'Building on the Kyoto Protocol: Options for Protecting the Climate', World Resources Institute, Washington, DC [available at http://climate.wri.org pubs_pdf. cfm?PubID=3762].

Baumert, K., Winkler, H., 2005. 'SD-PAMs and international climate agreements', in: R. Bradley, K. Baumert, J. Pershing (eds), *Growing in the Greenhouse: Protecting the Climate by Putting Development First,* World Resources Institute, Washington, DC, 15–23.

Bodansky, D., Chou, S., Jorge-Tresolini, C., 2004, 'International Climate Efforts Beyond 2012', Pew Center on Global Climate Change, Arlington, VA, USA [available at http://www.pewclimate.org/].

Bradley, R., Pershing, J., 2005, 'Introduction to sustainable development policies and measures', in: R. Bradley, K. Baumert, J. Pershing (eds), *Growing in the Greenhouse: Protecting the Climate by Putting Development First,* World Resources Institute, Washington, DC, 1–14.

CSD (Commission on Sustainable Development), 1995, 'Indicators of sustainable development: guidelines and methodologies', United Nations, New York, [available at www.un.org/esa/sustdev/indisd/indisd-mg2001.pdf].

DME [Department of Minerals and Energy], 2003, 'Integrated Energy Plan for the Republic of South Africa', DME, Pretoria [available at http://www.dme.gov.za/].

DME [Department of Minerals and Energy], 2005, 'Energy Efficiency Strategy of the Republic of South Africa, March 2005', DME, Pretoria [available at http://www.dme.gov.za/pdfs/energy/efficiency/ee_strategy_05.pdf].

ERI [Energy Research Institute], 2000a, *Energy Efficiency Guidebooks. Electrical Energy Saving*. ERI, University of Cape Town.

ERI [Energy Research Institute], 2000b, *Energy Efficiency Guidebooks. Electrical Energy Saving: Refrigeration and Thermal Saving*. ERI, University of Cape Town.

Geller, H., DeCicco, J., Laitner, S., 1992, *Energy Efficiency and Job Creation*. American Council for an Energy-Efficient Economy (ACEEE), Washington, DC.

Grobler, L., den Heijer, W., 2004, 'The Measurement and Verification Guideline for Energy Service Companies', Measurement & Verification Team, North-West University, Potchefstroom, North West Province, South Africa.

Höhne, N., Phylipsen, D., Ullrich, S., Blok, K., 2004, 'Options for the Second Commitment Period of the Kyoto Protocol', Federal Environmental Agency (Umweltbundesamt), Berlin, Germany.

Howells, M.I., 2004, *Modelling Multiple Goals: Greenhouse Gas Mitigation and Socio-economic Development,* Energy Research Centre, University of Cape Town, Cape Town.

Howells, M.I., 2006, 'Targeting of industrial energy audits for DSM planning', *Journal of Energy in Southern Africa* 17, 58–65.

Howells, M., 2007, 'Mapping out development pathways for climate friendly economic growth in a developing country', *International Journal of Energy Technology and Policy (Special Issue: Modeling Technology Characterization),* in press.

Howells, M., De Villiers, M., 1999, *Sustainable Energy for South Africa: Energy and the Environment*, Energy Research Institute, University of Cape Town, Cape Town.

Howells, M., Laitner, J.A., 2005, *Industrial Efficiency as an Economic Development Strategy for South Africa,* American Council for an Energy-Efficient Economy (ACEEE), Washington, DC.

Howells, M., Laitner, S., 2003, *A technical framework for greenhouse gas mitigation in developing countries,* Energy Research Institute, University of Cape Town, Cape Town.

Hughes, A., Trikam, A., Howells, M., 2003, *Energy Efficiency Savings*, Energy Research Institute, University of Cape Town.

IAEA [International Atomic Energy Agency], UNDESA [United Nations Department of Economic and Social Affairs], IEA [International Energy Agency], Eurostat, EEA [European Environment Agency], 2005, *Energy Indicators for Sustainable Development: Guidelines and Methodologies*, Vienna, Austria.

IPCC [Intergovernmental Panel on Climate Change], 1996, *Revised 1996 Guidelines for National Greenhouse Gas Inventories,* Organisation for Economic Co-operation and Development (OECD), Paris.

Jeftha, L., 2003, *Energy Efficiency and Job Creation: An Input–Output Model Approach*, Energy Research Institute, University of Cape Town, Cape Town.

Laitner, S., Bernow, S., DeCicco, J., 1998, 'Employment and macro-economic benefits of an innovation-led climate strategy for the United States', *Energy Policy* 26(5), 425–432.

Laitner, S., De Canio, S.J., Peters, I., 2001, 'Incorporating behavioral, social and organizational phenomena in the assessment of climate change mitigation options', in: E. Jochem, D. Bouille, J. Sathaye (eds), *Society, Behavior and Climate Change*, Kluwer, Amsterdam.

Metz, B., Davidson, O., Swart, R. and Pan, J. (eds), *Climate Change 2001: Mitigation. Contribution of WG III to the Third Assessment Report of the IPCC,* Cambridge University Press, Cambridge.

NER [National Electricity Regulator], 2003, *Energy Efficiency and Demand-side Management Policy within the South African Electricity Industry,* NER, Pretoria [available at http://www.ner.org.za/].

NER [National Electricity Regulator], 2004, *National Integrated Resource Plan 2 (NIRP2) 2003/4,* NER, Pretoria [available at http://www.ner.org.za/].

Raskin, P., Gallopin, G., Gutman, P., Hammond, A., Swart, R., 1998, *Bending the Curve: Toward Global Sustainability. Report of the Global Scenario Group,* Stockholm Environment Institute, Boston, MA, USA.

Spalding-Fecher, R., Winkler, H., Dick, A., Jeftha, L., Laitner, J.A., 2003, 'Modeling economy-wide impacts of investments in industrial energy efficiency: a South African case study', in: *Proceedings of the ACEEE Summer Study on Industrial Energy Efficiency (Vol. 6)*. American Council for an Energy-Efficient Economy (ACEEE), Washington, DC, 6-219–6-230 [http://aceee.org/conf/03ss/03ssindex.htm]

Thorne, S., La Rovere, E., 1999, 'Criteria and indicators for the appraisal of Clean Development (CDM) projects', presentation at Fifth Conference of the Parties to the Framework Convention on Climate Change, Bonn, 26 November.

Trikam, A., 2002, 'Greenhouse gas mitigation options in the industrial sector', *South African Journal of Economic and Management Sciences* 5 (2), 473–498.

UNFCCC, 1992, *United Nations Framework Convention on Climate Change*, United Nations, New York [available at http://unfccc.int/2860.php].

UNFCCC [United Nations Framework Convention on Climate Change], 1997, *Kyoto Protocol to the United Nations Framework Convention on Climate Change*. UNFCCC Secretariat, Bonn, Germany [available at http://unfccc.int/essential_background/convention/items/2627.php].

Van Horen, C., 1996, *Counting the Social Costs: Electricity and Externalities in South Africa,* University of Cape Town Press and Elan Press, Cape Town,.

Winkler, H., Spalding-Fecher, R., Mwakasonda, S., Davidson, O., 2002a, 'Sustainable development policies and measures: starting from development to tackle climate change', in: K. Baumert, O. Blanchard, S. Llosa, J.F. Perkaus (eds), *Building on the Kyoto Protocol: Options for Protecting the Climate*, World Resources Institute, Washington, DC, 61–87.

Winkler, H., Spalding-Fecher, R., Mwakasonda, S., Davidson, O., 2002b, 'Sustainable development policies and measures: tackling climate change from a development perspective', in: O. Davidson, D. Sparks (eds), *Developing Energy Solutions for Climate Change: South African Research at EDRC*, Energy and Development Research Centre, University of Cape Town, Cape Town, 176–198.

Appendix

Employment effects of industrial energy efficiency

In order to estimate economy-wide effects of employment as well as changes in electricity needs, an input–output (I–O) approximation was used. The approach is based on the work of Spalding-Fecher et al. (2003), who considered energy efficiency investments, and is expanded to include investments in new coal-fired power stations. The expanded approach is used to calculate economy-wide requirements for labour and electricity with investments in energy-efficient measures in industry as well as new power stations. This approach is described in detail in Howells (2004) and Howells (2007). Below we summarize economy-wide changes as a function of a change in sector output in terms of income (wage) and electricity multipliers as well as economy-wide changes in output as a function of the new investments.

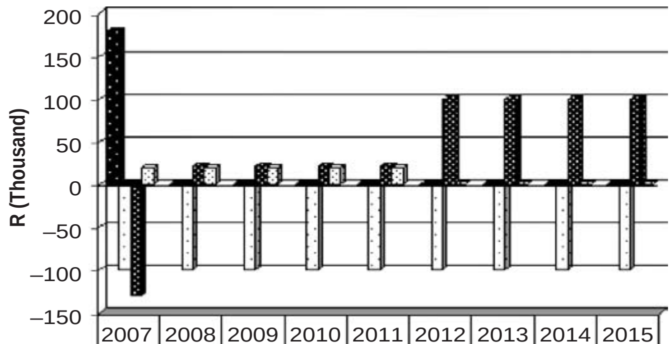
The multipliers (kWh and job-year) for an increase in sector output (million rand) are summarized in Table A1 by sector. For a more detailed description of how the multipliers were calculated from the national social accounting matrix please see Spalding-Fecher et al. (2003). By combining these with changes in required output per sector, changes in electricity and job-year needs can be calculated.

Income and electricity multipliers were calculated as a function of changes in income in the energy system from 'business-as-usual' patterns which characterize the SD-PAM used. (At this time South African electricity prices were based mostly on running costs at a time when excess capacity reduced the need for new investments in generation capacity.)

New power station investment and industrial energy efficiency options are associated with changes in output from several sectors. Expenditure patterns change over time: initially being negative as capital is expended and then recouped through energy savings or through increases in the electricity tariff. For power plants, the tariff is based on allowing a fixed rate of return for new investments (NER, 2004). These expenditure changes are summarized for typical investments in Figures A1 and A2 – for the saving of 1 GWh; this assumes a payback period of 3 years and 60% local content, or investment in 1 MW of coal capacity, following the assumptions given in NER (2004) and assumed 60% local content. From these, summarized coefficients are derived and included in MARKAL. By including the extra requirements for electricity, rebound effects are

TABLE A1 Economy-wide job-years and GWhs required per million rand of sector output

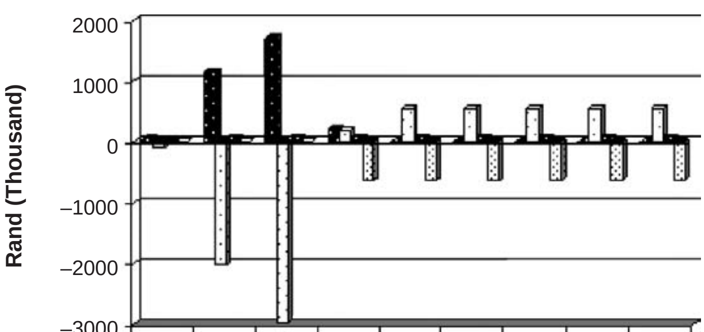
Sector	Economy wide job-years per Rmillion	Economy-wide GWhs per Rmillion
Agriculture	14	1.1
Mining	21	4.8
Manufacturing	19	2.5
Electricity	16	
Trade	27	1.2
Construction	25	1.5
Finances	48	1.0
Services	19	1.9



	2007	2008	2009	2010	2011	2012	2013	2014	2015
Construction	180	0	0	0	0	0	0	0	0
Electricity	–100	–100	–100	–100	–100	–100	–100	–100	–100
Manufacturing	–129	20.86	20.86	20.86	20.86	100	100	100	100
Finance	19.14	19.14	19.14	19.14	19.14	0	0	0	0

Year

FIGURE A1 Changes in income by sector for a saving of 1 GWh of electricity.



	2007	2008	2009	2010	2011	2012	2013	2014	2015
Construction	54	1160	1735	216	0	0	0	0	0
Electricity	–94	–2022	–2979	188	548	548	548	548	548
Finance	4	88	88	88	88	88	88	88	88
Other	0	0	0	–636	–636	–636	–636	–636	–636

Year

FIGURE A2 Income by sector for 1 MW of new coal-fired electricity plant.

accounted for. Note that changes in requirements in the electricity sector are calculated using MARKAL explicitly rather than using the multipliers from the I–O model. By including a job-year coefficient, economy-wide job changes are accounted for.

Using these coefficients, in the MARKAL model, a 'base case' is run and changes are compared with a run where energy efficiency investments are allowed. The differences are reported in terms of jobs created and emissions reduced.