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Joint Implementation Initiatives in South Africa: A Case Study of Two Energy-Efficiency Projects

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and Gretchen Parker

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JOINT IMPLEMENTATION INITIATIVES IN SOUTH AFRICA: A CASE STUDY OF TWO ENERGY-EFFICIENCY PROJECTS

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ABSTRACT

This paper explores the issues pertinent to Joint Implementation in South Africa by examining two prototype potential projects on energy efficiency with the potential for reducing greenhouse gas emissions. The first is an energy-efficient lighting project based on the public electricity utility, Eskom's plan for a compact fluorescent lighting program in the residential sector. The analysis indicates that the CFL program could avoid emissions of up to 243 thousand tons of carbon over the first five years, at negative cost (that is, with a positive economic return). The second project involves the delivery of passive solar, energy-efficient housing to a low-income township in the Western Cape Province, at an incremental capital cost of approximately $2.5m for the 6000 houses. In this case, the avoided GHG emissions over the first five years amount to between 14 and 20 tons of carbon, and over the 50 year life-span of the project it will result to 140 to 200 thousand tons of avoided emissions at a cost of $13 to $17 per ton. The housing project has significant non-GHG benefits such as savings on energy bills and health, which accrue to the low-income dwellers.

A number of important JI-specific issues and concerns emerge with respect to the two projects, which can also be applied to other potential JI opportunities in the country generally. These include the issues of carbon credit sharing, for which a number of scenarios are suggested, as well as estimating unknown macroeconomic impacts, such as the effects of CFLs on the country's incandescent lighting industry. Findings from an examination of both potential projects conclude that capacity-building within the country is critical to ensure that the technology being transferred balances efficiency, cost and quality appropriate to the South African context.

Finally, assessment and evaluation, monitoring and verification criteria and institutions are called for to guarantee measurable long-term environmental, economic and other non-GHG related benefits of potential JI projects.

Key words: *South Africa, joint implementation, energy efficiency, CFL, low- income housing.*

1. INTRODUCTION

South Africa presents an interesting potential case from a joint implementation perspective. The country had a population of about 42 million in 1996, with a per capita GDP of about $3000, placing it in the 'upper-middle income' category in the World Bank tables (World Bank 1997). The three years since the first democratic elections in April 1994 have seen positive real rates of economic growth of around 3 percent per annum, although these followed a decade of economic decline in the mid-1980s and early 1990s, so that real income levels are considerably lower than they were in the early 1980s. Unemployment is a major problem, with about 40 percent of the work force lacking formal employment; consequently, the informal economy provides the basis for survival for a large part of the population.

The new government has pursued a cautious fiscal and monetary policy aimed at achieving two primary goals: more vigorous economic growth, reaching 6 percent per annum by the turn of the century, and, at the same time, rapid investment in social infrastructure such as housing, electricity, water and education. This is in a context where the economy has been liberalized considerably since the re-integration of the country into the international economy after the demise of apartheid.

Several features stand out in relation to South Africa and the climate change issue: firstly, it is classified as a non-Annex 1 country, and so does not face any immediate greenhouse gas (GHG) abatement targets flowing out of international negotiations. Secondly, GHGs are very significant in its economy. At an aggregate level, South Africa accounts for only 1.4 percent of global carbon dioxide emissions or 1.2 percent of total GHG emissions, according to a national inventory study undertaken with 1988 data (Scholes & van der Merwe 1995). However, the 1992 Stockholm Environment Institute (SEI) global GHG inventory found South Africa to be the largest source of GHGs in Africa, accounting for 15 percent of the continent's carbon dioxide emissions and 11 percent of methane emissions (Subak et al 1992). The same source reported that South Africa was the eighteenth largest emitter of carbon dioxide in the world, larger even than countries such as the Netherlands, Turkey and Australia (all 'Annex 1' countries). Furthermore, this source underestimated South Africa's emissions considerably: CO_2 emissions

were estimated at about 250 Mt compared with the more recent South African estimate of 350 Mt. The difference is probably the result of the historical lack of public access to quantitative information about the petroleum industry.

On a per capita basis, South Africa's GHG emissions are well above global and African averages: in 1988, average carbon dioxide emissions were just under 10 tons per person per annum in South Africa, compared with the global average of just over 4 tons and the African average of just over 2.5 tons (van Horen & Simmonds 1996). Similarly, the country produces less economic output per unit of carbon dioxide emitted than most countries (refer to Table 1)

Table 1. Emissions in Selected Countries in 1990, in Relation to Population and GDP

	CO_2 emissions (Mt/year)	**CO_2 per capita (t/year)**	**US$ of GDP per ton of CO_2**
High-income countries			
United States	4 569	18.3	1 180
Japan	1 005	8.1	2 928
Germany	990	12.5	1 503
United Kingdom	564	9.8	1 729
Netherlands	180	12.1	1 551
Middle-income developing countries			
Brazil	990	6.6	418
Mexico	491	5.7	484
South Korea	209	4.9	1 131
Greece	73	7.2	793
South Africa	350[1]	9.7	259

(van Horen & Simmonds)

South Africa signed the U.N. Framework Convention on Climate Change (UNFCCC) in June 1993, but for a number of reasons, including South Africa's domestic focus preceding and

[1] Emissions for 1988 as per Scholes and van der Merwe (1995: iii).

following the country's first democratic elections and the need for a participatory process of consultation with regard to the development of climate change policy, ratification of the Convention was considerably delayed. In mid-1996, a National Committee on Climate Change (NCCC) was constituted. The NCCC is a non-exclusive committee, including representatives from central and provincial government, non-governmental and community-based organizations, business and industry, labor and the research community. The primary objective of the NCCC is to advise the minister of the Department of Environmental Affairs and Tourism (DEAT), which is responsible for the administration of the Convention, on national issues related to climate change. Its specific roles are to communicate key events and the policy development process to interested and affected parties, develop a national position on climate change issues, oversee the South African Country Studies Program and develop a national position on Activities Implemented Jointly/Joint Implementation. With the explicit support of the NCCC, ratification of the Framework Convention finally took place on 29 August 1997, just in time to allow South Africa's full participation in the December 1997 Kyoto Conference of the Parties.

While South Africa has taken no position on Joint Implementation (JI), it has come out in support of the concept of Activities Implemented Jointly (AIJ). This is a strategic move on South Africa's part, which hopes to gain experience through a finite and voluntary pilot phase which will be used to formulate a position on JI, while firmly aligning itself with the Africa Group, G-77 & China, SADC and Valdivia, of which South Africa is a member. South Africa's participation in the AIJ phase is conditional on the following (NCCC 1997):

- Projects must contribute to national development programs, specifically the objectives of mass housing, water provision, education and electrification as outlined in the Reconstruction and Development Program.
- Evaluation, reporting and monitoring performance of AIJ projects must be transparent.
- Projects must contribute to the achievement of the objective of the UNFCCC by aiming to bring about in a cost-effective manner real, measurable and long-term environmental benefits related to the mitigation of climate change that would not have occurred in the absence of such activities.
- Funding for AIJ projects should be additional to all existing funding and technology transfer provided for under the UNFCCC.

- The AIJ pilot phase must be used to develop capacity in South Africa.

The South African Minister of Minerals and Energy signed a Statement of Intent in early 1996 with his United States counterpart committing both parties to investigate joint projects which produce global environmental benefits. Although JI and AIJ were not explicitly mentioned, it was clear that AIJ projects fell within the scope of the statement. More recently, several AIJ project proposals have been put forward, including the energy-efficient housing project discussed here which anticipates USIJI secretariat approval early in 1998. A steel industry sector energy-efficiency project is also under consideration by the AIJ Working Group of the NCCC, which is acting as the interim clearing-house for registry and assessment of proposed AIJ projects as a part of the approval process.

Given its position both as a relatively high emitter of GHGs and as a middle-income country with the potential for significant economic growth, South Africa is likely to develop a special interest in JI projects. On one hand, South Africa's energy- and GHG-intensive economy presents many potential prospects as a host country for investors seeking credit for GHG reductions. On the other hand, because it is a relatively advanced and (high per capita GHG-emission) developing country which could face abatement commitments of its own in the future (Rowlands 1996), this raises the stakes in the JI debate. Against this background, it is pertinent to consider two possible JI case studies as a means of mapping out the benefits and challenges, which would arise if a more aggressive JI regime were to be instituted globally.

2. POTENTIAL JI-TYPE PROJECTS: AN ENERGY-EFFICIENT LIGHTING PROGRAM AND AN ENERGY-EFFICIENT HOUSING PROJECT

This section explores the issues and concerns arising out of two potential Joint Implementation projects in South Africa as a means of mapping out the benefits and challenges which would arise if international discussions about a greenhouse gas tradable credits scheme are instituted. The first project is an energy-efficient lighting project based on the country's public electricity utility (Eskom) plan for a compact fluorescent lighting program for the residential sector. The second project involves the delivery of passive solar, energy-efficient housing to a low-income

township in the Western Cape Province based on a proposal by a non-governmental organization – International Institute for Energy Conservation (IIEC), and a consulting firm (PEER Africa) for piggy-backing the project on an existing government housing program. Conclusions are drawn regarding the main institutions, policies and research requirements needed to implement an energy-efficiency-related project in South Africa.

2.1 Energy-Efficient Lighting Program

2.1.1 Background

In mid-1996, Eskom launched a major resource plan referred to as the 'Integrated Electricity Plan', which included various demand- and supply-side components, one of which is a residential demand-side management (RDSM) program. The three main reasons put forth by Eskom justifying the introduction of this program are:

- to sustain the decline in the real price of electricity;
- to increase electricity's competitiveness in the small-customer energy market; and
- to contribute towards environmental conservation and awareness (Eskom 1996b).

Climate change and greenhouse gas emissions do not feature in any explicit way in the rationale for the RDSM, and it is probably fair to say that Eskom is more concerned with national environmental problems than global ones. The RDSM program has therefore not been designed with a view to JI projects. This paper evaluates the program from a JI perspective.

Within the RDSM, Eskom has identified a number of programs with potential, such as time-of-use tariffs, water heating load management, appliance labeling, thermal efficiency of dwellings, limited supply capacity, consumer education and efficient lighting. It is the last of these which is the focus of this case study. Due to the fact that energy-efficient lighting is already a part of Eskom's business plan, the question of additionality becomes pertinent. However, while Eskom has stated its intent, the pilot phase of the project has been repeatedly delayed and implementation has yet to occur.

Eskom's energy-efficient lighting project was born largely out of a concern for the increasing peak to base load ratio of Eskom's residential power supply, and the negative effect this has on the cost of supplying electricity. While residential consumption accounts for only 15 percent of South Africa's national electrical energy consumption, it constitutes 75 percent of the national variable load (Naud[a] & Lane 1996). Furthermore, the accelerated electrification program threatens to increase the impact of residential peaks on the national load profile. Since the launch of the national electrification program in 1991, over 2 million additional household electricity connections have been made by Eskom and other municipal power distributors (National Electricity Regulator 1996), thus negatively affecting the utility's load profile (van Horen *et al* 1993).

The main rationale for the utility's compact fluorescent lighting (CFL) program is to mitigate the impact on the peak of demand growth by existing and new consumers. While lighting contributes a relatively small proportion to Eskom's load profile (less than 10 percent), peak use of lighting coincides with the peaks of cooking, space heating and water heating. Furthermore, newly electrified households use electricity predominantly for lighting - with few base load appliances, thereby contributing disproportionately to these peaks.

Eskom has set ambitious goals in its energy-efficient lighting program. Due to the highly differentiated nature of the South African market, the program is targeted towards lights that contribute significantly to the total lighting load. Three consumer groups have been identified for the CFL program:

- in the high-income household sector, Eskom plans to replace 1.25 million incandescent light bulbs with CFLs over the five-year program period;
- in low-income households, the utility aims to install 576,000 CFLs in existing readyboards[2] over a period of five years;
- in low-income households which will be electrified in coming years, Eskom aims to install 2 million CFLs over five years.

[2] A readyboard is a unit attached to the wall of the dwelling containing a fixed light fitting as well as plugs for appliances and extension leads. Readyboards are supplied to all low-income households upon electrification, unless consumers pay for full wiring of their houses

The CFL lamps being used in Eskom's pilot projects have an expected life span of 5,000 to 8,000 hours, and cost in the region of $10 to $14 each. Eskom aims to aggressively promote CFLs over an implementation period of five years. Thereafter, it is expected that sales of CFLs will continue at the same momentum with reduced marketing efforts.

At present, South Africa has no capacity to produce CFLs domestically and so importation of the lamps will be necessary, at least in the short term. It is possible, however, that demand from consumers in this country will grow to the extent that sufficient economies of scale will be present for a local producer to establish production capabilities; discussions along these lines were held between the Department of Trade and Industry and potential investors in early 1996, although no immediate investments were forthcoming.

2.1.2 Direct Project Impacts

Project Costs

Preliminary estimations of total costs of the project, based on the utility's contribution to the cost of the CFLs (ranging between U.S. $10 and $14) installed over the five years of the program and the direct marketing and support costs associated with the dissemination of the lights, are between $45 and $65 million.

Project-specific economic impacts

The main economic impacts from Eskom's CFL program include, on the cost side, the incremental capital costs of the CFLs as compared to normal incandescent light bulbs, and the promotional and marketing costs to support the dissemination of the lights. The benefits include the reduced operating costs of CFLs and the avoided costs of meeting peak demand. To date, experience with these costs and benefits has been fairly limited and thus only a rough approximation of net economic impacts can be made.

Based on assumptions and data about capital and operating costs of various light bulbs, as well as avoided costs of peak capacity, the net economic benefit of installing one CFL can be calculated (see Table 2).

Table 2. Incremental Economic Benefit of 15W CFLs (Compared to a 75W Incandescent Bulbs) *(data source: Eskom 1996b)*

	Incandescent	**CFL**	**CFL**
Period analyzed (hours)	8,000	8,000	8,000
Discount rate (%)	8	8	8
Exchange rate (R/$)	4.68	4.68	4.68
Electricity price (US c/kWh)	4.27	4.27	4.27
Wattage (W)	75	15	15
Life span (hours)	1,000	5,000	8,000
Hours used per day	5	5	5
Lamp cost ($)	0.53	10.00	14.00
Cost of peak capacity ($/kW)	534.19	534.19	534.19
Cost of energy for 8000 hours ($)	25.64	5.13	5.13
Net Present Value (NPV) of life cycle cost ($)	24.44	23.24	18.67
NPV of avoided cost to consumer ($)		1.20	5.77
NPV of avoided cost of peak ($)		32.05	32.05
NPV of net economic benefit ($)		33.25	37.82

Based on the assumptions listed, the net present value derived from replacing an incandescent with a CFL will be between $33 and $38, based on a time period of 8,000 hours and a real discount rate of 8 percent. By applying these net economic values to the CFL installation scenarios (915,200 CFLs per annum over a period of five years), it is possible to calculate the aggregate economic effects. Over five years, the net economic value of the proposed CFL Program, taking into account estimated marketing and support costs of $1 million per annum, amounts to between $119 and $135 million in net present value terms (see Table 3).

Table 3. Net Economic Value of Proposed CFL Program Over 5 Years

	15W CFL (5000 hours)	**15W CFL (8000 hours)**
Number of CFLs installed per annum	915,200	915,200
Net economic value per CFL per annum	$33.25	$37.82
Gross economic value per annum ($m)	30	35
Promotional and marketing costs per annum ($m)	1	1
NPV of total program ($m)	118.77	135.48

(data source: Eskom 1996b

Clearly, this calculation is based on a number of variables, which may change as the program proceeds, notably the capital cost of CFLs, but it gives an indication of the scale of expected benefits from the CFL program.

GHG benefits

Over five years, the CFL program would reduce electricity production by about 1,002 GWh, based on the assumptions listed above. Eskom's emissions of CO_2 in 1994 were 142.9 million tons (Eskom 1995) which, based on electricity output of 160,293 GWh, yields an average emission factor of 891 tons of CO_2 per GWh produced. Significantly, however, this average probably overstates the amount of GHG emissions, which would be avoided by the CFL program, since it will reduce the amount of peaking power that has to be generated. Eskom's supply mix is such that base load is met by its coal and nuclear power stations, while peak power needs are met with pumped storage hydro schemes and gas turbines. The pumped storage schemes are, in turn, effectively powered by base load stations during off-peak periods and so a reduction in peak demand would indeed lead to reduced CO_2 emissions. A practical difficulty remains, however, insofar as there is no clear way of matching reduced peak demand with reduced generation, especially when there are similar DSM programs being implemented simultaneously.

At most, therefore, the CFL program would avoid 892,782 tons of CO_2 over its first five years. This represents just 0.62 percent of Eskom's total emissions for 1994 alone, or about 0.1 percent

of its expected emissions over the same five-year period. Over a ten-year period, the same CFL program would reduce emissions by about 1.9 percent of Eskom's 1994 levels, or 0.2 percent of its expected total emissions over that period.

From this, it is clear that the GHG benefits of the CFL program do not feature prominently in relation to the direct economic effects. Nonetheless, because the CFL project has a positive economic return, it will be one of the first GHG abatement projects to be implemented, whether as a JI project or not.

2.2 Energy-Efficient Housing Program

2.2.1 Background

Like the CFL program, the proposed energy-efficient housing project discussed here is aimed at reducing CO_2 emissions for the residential sector. Known as the Guguletu Eco-Homes (Energy Cost Optimized) Project, the 6,000-home planned development is located in the Cape Town metropolitan area in the Western Cape province. The project was submitted for review and approval to the U.S. Initiative on Joint Implementation (USIJI) for certification as an AIJ pilot-phase project. The proposed project involves the use of thermally-efficient design measures in a new low-income housing program. Measures such as the optimization of dwelling solar orientation, correct window sizing and positioning, provision of wall and ceiling insulation, and energy-efficient lighting could reduce carbon dioxide emissions from heating, cooking and lighting activities (Parker 1997).

The primary energy sources for these services are currently kerosene and electricity in the Cape Town region. The project, which will be funded by the South African government's income-scaled housing subsidy, seeks AIJ accreditation to help overcome the existing barriers to thermally-efficient, low-income homes in South Africa. Homes built to date through the government's Reconstruction and Development Program (RDP) do not incorporate energy-efficient design measures, often resulting in homes only marginally better in terms of energy consumption, emission reduction and habitability than the shacks they are replacing. Less than 20 percent of these homes include a ceiling, and a negligible few percent have made provision

for insulation (IIEC 1997). Institutional barriers to energy-efficient housing development currently existing in South Africa include, but are not limited to:

- An incentive system that rewards developers who forsake home quality by minimizing investment in energy-efficient options. There is no incentive to include even the simplest of thermal efficiency measures since contractors are paid by the government only *after* project completion, and are not held to any set government housing standards.
- Lack of awareness of the potential for cost-effective energy-efficient measures and technologies;
- Lack of interest by international technology providers and material suppliers in the low-income sector in developing countries and emerging economies; and
- Lack of an implementation process and techniques to achieve both cost and environmental goals.
- Lack of domestic financial instruments (affordable public and private credit facilities) for low income housing
- Lack of incentives by the power company and municipal suppliers who would benefit from avoided new capacity installation. This attitude is partly due to the existence of over-capacity in the power system for the last decade.

The housing delivery process proposed by PEER Africa – a civil and environmental engineering consulting firm, which is the U.S. project participant with a proven track record in a similar housing development outside Kimberly, is designed to help overcome these barriers. The proposed project seeks to demonstrate that cost-effectiveness and energy-efficiency are not incompatible, and can be delivered within the existing RDP housing subsidy. The other two participants in the project are the Community of Guguletu (a limited trust development company), and IIEC (a US-registered non profit organization) (IIEC 1997).

2.2.2 Direct Project Impacts

Project costs

A RDP subsidy of up to (17,000 Rand) U.S.$3,900 per family will be the primary funding source for the proposed AIJ project. The subsidy is intended to help finance municipal services, land ownership clearance, project management, and the housing structure itself. To the extent

possible, small amounts of additional funding such as utility rebates for energy-efficient lighting may also be sought (see Section 2.1).

While municipal services and land ownership clearance must be secured in any type of housing development, some of the immediate costs associated with project management and housing construction will be higher for an energy-efficiency housing project. The majority of interventions associated with the proposed Eco-home project construction are no-cost measures, such as building orientation and window sizing. Other energy-efficiency measures such as insulation, ceilings and CFLs do involve an incremental cost, with positive financial returns as indicated by the CFL example in Section 2.1. Consultancy costs related to the thermal efficiency aspects of project management, such as technical expertise and awareness-raising, will add approximately U.S. $2.5 million to the project cost beyond that of standard contractor-built homes. Table 4 lists the activities requiring investment by PEER Africa with their associated costs (core activities in shaded rows). The success of these activities will determine whether the proposed project would achieve energy savings of either 50 or 70 percent.

Based on the cost data presented here, assuming that these activities are adequate for implementing the whole project, the cost of the energy-efficiency component of the proposed project is about U.S. $425 per Eco-house. This figure is the maximum cost estimate since some of the activities listed in Table 4 would have been partially or fully funded from the subsidy even if the homes built were not thermally efficient. Therefore, the maximum total cost of the 6,000-home project is the $24 million covered by the subsidy, plus the $2.5 million additional investment by PEER Africa targeted for energy efficiency, or $26.5 million.

Table 4. Cost of Energy-Efficiency-Related Activities of Eco-Home

Activity	Investment Type	Estimated Investment (US$)
Construction of two demonstration homes in Guguletu	Materials, labor, travel, engineering and managerial support	50,000
Advisory support to community	Person-days	67,200
Workshops in community	Person-days	48,000
Optimization of Eco-Home design for Guguletu	Architectural and engineering expertise	50,000
Discussions and negotiations with municipality on site servicing	Person-days	96,000
Discussions with municipality/ community on subsidy processing	Planning, management, administrative support	160,000
Training of construction teams	Person-days, training materials	170,000
Project management and supervision	Person-days, travel	1,315,000
Arranging bulk purchasing agreements	Person-days, travel	83,000
Establishment of local industrial parks	Person-days, travel	250,000
Behavioral training on optimizing the Eco-Home	Person-days	208,000
Communications and outreach	Person-days, outreach materials	50,000
	Total Investment	**US$2,547,200**

(data source: IIEC, 1997)

Project-specific economic impacts

The capital cost of the proposed Eco-Homes project will be reimbursed by the government subsidy, as indicated above. Economic benefits of the project would accrue primarily to the homeowner in a number of direct and ancillary ways.

Homes built under the current government-contractor arrangement fail to incorporate even the simplest thermal measures, supplying residents with little improvement over their previous shacks that left them cold in the winter and hot in the summer. Building in technologies that make homes responsive to the local climate is significantly less expensive when performed at the time of construction, and results in dwellings that are affordable, more healthy, and that significantly reduce CO_2 emissions.

Benefits incurred from the proposed Eco-Home project include improvements in family health, economic well-being, comfort, employment, safety, and opportunities for women. If the energy requirement for space heating is reduced by as much as 70 percent, the paraffin-using households – the majority of non-electrified houses, would save about 100 liters each winter thus saving about U.S. $40. Since electrification is being extended to the 2.5 million houses that are currently unelectrified, and one million low-cost homes are planned in any case, it is assumed that that the overall impact to the environment can be reduced by introducing energy-efficiency measures, even if it means an increased take-back in total electricity use. However, these benefits can be only partially quantified economically. For example, in addition to the direct annual treatment costs of respiratory disease of about U.S.$75 million due to exposure to coal combustion in South Africa (van Horen 1996), indirect costs such as losses in productivity and quality of life prove more difficult to quantify.

Capital costs of purchasing fuel such as kerosene and electricity have a bearing on the access to employment and economic opportunities in communities. Numerous studies have found that the poorest households (those eligible for the RDP housing subsidy) pay the largest portion of household income on meeting basic energy needs such as heating and cooking, amounting to about 11% (Simmonds and Mammon, 1996). Improving the affordability of these energy

services will result in improved payment for services, liberated household income to use for small business development or other priority investment, and ability to meet other basic needs.

The proposed project will also raise employment in the community. In contrast to a standard contractor-built project that brings in outside professionals and leaves only 2 percent of the housing subsidy with the community, PEER Consultants is committed to shifting 30 percent of the subsidy to the local economy by training unemployed people, including women, and putting them to work on the job site. In another housing project at Kutlwanong (IIEC, 1997), construction of 2,300 units created 120 local jobs, 10 percent of which went to women. If the same assumptions pertain to Guguletu, the project would create more than 300 paid jobs in construction – a significant impact for a community with 80 percent unemployment. Furthermore, the project generates other employment in the housing material supply sector. It is not easy to discern, however, how many of these jobs would have been created with an RDP project lacking any improved thermal performance, though experience in other standard contractor arrangements suggests very little local job creation occurs, since outside professionals are brought in and local labor is used only for unskilled tasks (PEER and IIEC, personal com).

Reducing the amount of energy required to maintain comfort in the home will also reduce the incidence of three chief safety concerns related to energy use: poisonings, burns and fires. Over 10,000 children a year are accidentally poisoned by ingesting kerosene, burns are one of the top four killers of children under 14, and house fires destroy the property and lives of large portions of the community (Eberhard and van Horen, *1995*).

GHG benefits

CO_2 savings for the proposed project will be realized from the reduced use of electricity and kerosene for space heating and lighting provided by the improved thermal performance of the Eco-Home and promotion of the use of energy-efficient lighting. Space heating and lighting each account for about 30 percent of annual energy consumption for low-income homes in Cape Town (IIEC 1997). CO_2 savings can be claimed upon habitation of the Eco-Home, and maintained for the estimated 50-year life span of the project, adjusting for an increased take-up in energy use for the first 15 years.

Table 5 shows baseline estimates for energy consumption for space heating and lighting in the standard informal and formal housing stocks in the low-income housing sector in Cape Town. Space heating in the region is accomplished through the combustion of kerosene and the use of electricity, depending on household access to appliances, preferences, and ability to afford fuels. The proportion of energy used for space heating is assumed to remain constant over the transition (5-15) years of the project. The proportion of electricity consumption dedicated to lighting is also assumed to remain constant for the duration of the study.

Table 5. Assumptions for Baseline Dwelling Energy Use

Informal, low-income dwelling energy data, Cape Town			
Energy Carrier	**Consumption**	**Consumption**	**CO_2 Emissions**
Electricity	751 kWh/yr.	2.7 GJ/yr.	249.2 kg/yr.
Kerosene	559 liters/yr.	20.6 GJ/yr.	1,479.2 kg/yr.
Formal, low-income dwelling energy data, Cape Town			
Energy Carrier	**Consumption**	**Consumption**	**CO_2 Emissions**
Electricity	1,668 kWh/yr.	6 GJ/yr.	553.8 kg/yr.
Kerosene	432 liters/yr.	16 GJ/yr.	1,142.8 kg/yr.

(data source: Simmonds and Mammon, 1996; EDRC, 1996;Scholes and van der Merwe, 1994)

Under the baseline scenario, it is assumed that energy-use patterns will at first be similar to the present informal shacks that predominate in the area. A transition to formal dwelling energy use is expected for the next 10 years as standard contractor-built homes are delivered (where the values of energy consumption for the informal and formal sectors are interpolated over a ten-year period). Finally, energy use is conservatively assumed to remain constant in the formal sector for the remaining 35 years of the comparison period.

Table 6 compares CO_2 emissions projections for a baseline project of 6,000 standard-built homes versus 6,000 Eco-Homes in Guguletu, based on 50 percent savings (low efficiency scenario) and 70 percent (high efficiency scenario). Projections combine emissions from both kerosene and

electricity use, with an assumed 50% usage rate of CFL lighting for the Eco-Homes (in the absence of social acceptability). The cost of carbon reduction is generated from the energy-efficiency investment data as shown in Table 4, not the total project costs.

Table 6. CO_2 Emissions and Cost of Abatement per Eco-Home

Energy-savings Scenarios	**CO_2 emissions, first 5 yrs. (tC)**	**$U.S./tC emissions savings**	**CO_2 emissions, total over 50 yrs. (tC)**	**$U.S./tC emissions savings**
Baseline/standard home	4.77	—	48.4	—
Eco-Home, 50% energy savings	2.46	$ 80-90	24.2	$ 16-17
Eco-Home, 70% energy savings	1.48	$ 110-120	14.68	$ 12-13

(data source: IIEC 1997)

Over the life of the project, the CO_2 savings is an estimated 7 tons per house in the low-energy-savings scenario, and 9 tons in the 70 percent energy-savings projection. Therefore, the total GHG-avoidance for all of the proposed 6,000 Eco-Homes is between 40,000 and 55,000 tons of CO_2 (IIEC 1997). However, the actual GHG savings critically depend on the accuracy of the baseline projections. Projects of such long life-span like the Guguletu housing project (50 years) carry more uncertainty than shorter term projects since a number of exogenous changes such as real income levels, income distribution, urban housing patterns, building standards and styles, fuel use, etc. can take place, and make it much more difficult to isolate the JI-relevant credits. For analytical purposes, this ambiguity about baseline projection calls upon putting more weight on the near term impacts than those in outer years. At the practical level, the length of these projects may require that the actual credits be assigned periodically – let say every 5 years, after a thorough verification of the savings. The downside of this approach is that it complicates the decision process for investing in the most cost effective JI projects, though a probabilistic assessment could be used to increase the comparability of projects with varying life-spans.

As a high emitter of GHG and as a country with an economy in transition, South Africa is well positioned to seek JI opportunities such as the potential energy-efficiency projects detailed above. The benefits of the CFL program are more economic than GHG-saving, while the proposed energy-efficient housing project promises significant GHG reduction with numerous no- and low-cost measures. The benefits of both scenarios accrue to residential home dwellers in a number of direct and indirect ways (particularly in the Eco-Home case), as well as to the utility Eskom in the form of avoided costs of meeting peak demand. The costs for the CFL program and the lighting component of the proposed housing project both require the increased capital costs of the CFLs themselves, as well as direct marketing and support costs associated with dissemination of the lights. Both projects are well positioned for implementation as JI-type projects.

At the national level, electricity and housing delivery are high government priorities, currently being implemented without energy efficiency components due to economic and institutional barriers. Preliminary steps by the government to address climate change concerns indicate an interest in cost-effective mitigation measures such as JI.

3. JI-SPECIFIC ISSUES AND CONCERNS

This section addresses a number of generic concerns commonly associated with JI projects in relation to South Africa's CFL program and the proposed Eco-Home housing project in Guguletu.

3.1 Additionality of Funds from Bilateral Sources

In principle, pilot JI projects are not supposed to detract from conventional development-oriented financial assistance, but are meant to attract additional sources of finance. If the present CFL program were structured as a JI project, it would be in the interests of a foreign JI investor to invest, since the project yields GHG savings at negative cost (net benefit). A condition for this to occur would be that Eskom compensates the JI investor for a portion of its own avoided costs, and Eskom would logically be prepared to pay up to the amount of those avoided costs. Of

course, in practice, account would have to be taken of the risks to both parties and other transaction costs but, in principle, it would seem that this would be an attractive project from a JI investor's perspective.

However, as already mentioned, the JI activity should also be additional to Eskom's own business plans. The fact that energy-efficient lighting is already part of Eskom's Integrated Energy Plan suggests that the project is not economically unattractive to Eskom and that it would go ahead with the project with or without JI investment. The question therefore arises, how would project implementation differ if it were a JI project? For example, could JI investment overcome financial barriers to participation in the energy-efficient lighting program in the low-income sector that would not be overcome if Eskom were to implement the program alone. This question is difficult to answer at this stage as Eskom is yet to define its strategies for implementing the program.

In the energy-efficient housing case, the issue of additionality is less of a factor as technical assistance, rather than direct outside funding, is being sought. The interested U.S. participant, in this case PEER Africa, would be investing technical (energy-efficient design) knowledge, project management experience and housing development expertise in the host country, South Africa, in return for a portion of theoretical carbon credits (discussed in Section 3.2). In contrast to JI-type projects involving tree planting or a large infrastructure development, an energy-efficient housing project in South Africa provides a 'one-off, ' or no regrets opportunity to include CO_2-saving measures in the project design, where they would not otherwise occur under the current housing scheme.

3.2 Sharing of Carbon Credits

The sharing of carbon credits is likely to be one of the most important issues for South Africa in the climate change debate generally and the JI debate specifically. Given its status as a relatively significant source of GHG emissions, coupled with its middle-income status, the prospect of future emission control targets being imposed on South Africa means that the cost of relinquishing low-cost GHG abatement options could grow in the future. Eskom, for one, is

hesitant to engage in JI projects because of its potential vulnerability on the GHG issue (Lennon 1996) and would therefore be very cautious before entering such agreements without clear criteria for the sharing of any carbon credits. At present, South Africa does not hold a formal position on sharing of carbon credits and it is hoped that the AIJ pilot phase will lead to greater understanding in South Africa of the implications of credit sharing.

Having said that, the different credit-sharing options discussed in the literature include:

- Total emissions reductions could be shared on the basis of the percentage of initial investment made by the host and the investor countries. This is, however, not considered fair as the host country will not share significantly in the benefits of the avoided GHGs.
- South Africa could establish a policy, which sets or fixes the credit-sharing ratio. For example, some countries have been calling for a 50/50 split of the total emissions reductions for all projects (Chatterjee & Fecher 1997). Predetermining the credit-sharing ratio may, however, discourage certain types of investment.
- Total emissions reductions could be shared on the basis of a percentage of initial investment and avoided costs, including avoided consumer power costs, avoided capital cost of generation and avoided cost of abatement abroad.

Table 7 demonstrates the implications of a range of hypothetical credit sharing scenarios for the cost and NPV per ton of carbon. Clearly, more research is required to determine the most appropriate and fair carbon credit-sharing scenario for these projects. Such research would need to include calculations of:

- The up-front or initial investment made by the host and investor countries.
- The net cash flows to each party.

The division of credits based on the above and determined by an agreed framework.

Table 7. Cost and NPV Per Ton of Carbon for Different Credit-Sharing Scenarios

		Investor's share			
Assigned credits	C	25%	50%	75%	100%
Cost/tC		$202-$291	$101-$146	$67-$97	$50-$73
NPV/tC		$532-$607	$266-$304	$177-$202	$133-$152

The lack of any formal framework for distribution of carbon credits necessitated the proposed energy-efficient housing project participants to experiment with creative applications of emissions trading with hopes of producing positive environmental and developmental outcomes. The three participants agreed on the following voluntary assignment of theoretical emissions credits which can be capitalized once an international carbon trading mechanism is established:

- 45 percent to PEER Africa for future carbon trading potential.
- 45 percent to the Community of Guguletu to help fund further sustainability projects within the community. The credits would be disbursed either communally to purchase a shared resource, or used to establish a revolving loan structure that would be accessible to individual families.
- IIEC would receive the remaining 10 percent of the theoretical credits which will either be "retired" in order to achieve environmental gains beyond the stipulated emissions reductions, or used to fund further climate change-related projects and thus extend the GHG emissions impact of the Guguletu project. (IIEC 1997).

3.3 Non-GHG effects

Two categories of non-GHG effects are pertinent here: firstly, economic effects, and secondly, other environmental effects.

Income distribution inequities are especially stark in South Africa's current energy situation. Most newly electrified households have not shared significantly in the country's wealth and have low incomes, with the result that energy expenditures account for a high proportion of their spending. As indicated previously, low-income households spend approximately 11 percent of

their monthly household expenditure on energy, compared with wealthier households which spend in the region of 4 percent (Simmonds & Mammon 1996). Other estimates have put the proportion of energy expenditure as high as 20 to 40 percent of total household income (IIEC 1994). Consequently, a reduction in the monthly energy bill resulting from the use of more efficient lighting will release scarce financial resources for other household needs. Poor households experiencing energy poverty may use these freed resources to meet other household energy needs (the 'take back' effect). Thus, although there would probably not be any major increase in savings rates in poor households, the effect of the CFL program would nonetheless be positive insofar as expenditure could be re-directed towards other needs. For example, low-income households currently spending U.S. $ 15 per month on meeting their cooking, lighting, media and space- and water-heating needs, may continue to spend U.S. $ 15 per month on energy even after their lighting costs have been reduced through CFL use, but achieving a higher level of energy service. It should be noted, however, that this implicitly assumes that the increased disposable income resulting from energy efficient interventions, is not expended again on items with higher GHG impacts. In practice, of course, this is extremely difficult to estimate.

A further non-GHG economic effect of the programs outlined here is their potential to achieve economies of scale in the production of energy-efficient and passive solar technologies, thus reducing the initial capital outlay to incorporate such measures.

Secondly, both the CFL program and the energy-efficient housing project would bring about a reduction in electricity generation. To the extent that electricity generation leads to negative health and environmental costs due to air pollution emissions and occupational hazards, any reductions in electricity generation would have positive effects in that regard, as discussed above in relation to benefits of the Eco-Home project. A recent study has estimated some of the external effects and found them to be an order of magnitude higher than the direct effects, especially in the case of coal power stations (van Horen 1996).

It would, however, be misleading to count these avoided external costs as a benefit of either of the programs, because of second-round substitution effects which would more than likely lead to a shift in consumption patterns towards non-lighting demands. Thus avoided emissions caused

by the use of CFLs and high thermal-performance homes may be offset by increased emissions due to higher demand for other energy services. The pertinent question is, therefore, whether the net effect is positive or negative. Ideally, the analysis should calculate the net GHG savings by offsetting against gross GHG savings, the incremental consumption, which results from increased demand for other services. In the absence of information about individual households' consumption profiles and their corresponding GHG-intensity, the comparison could be based on the GHG-intensity of the average consumption basket of the relevant consumer sectors; or at an even higher level of aggregation, the average GHG emission intensity for the economy as a whole (14.2 tC/$1000 GDP).

3.4 Lack of Assessment Methods for JI Projects

This is a generic problem in JI projects, and apart from broader questions about baseline levels of GHG emissions, more specific measurement and assessment problems arise in the case of the CFL program. Some of these were alluded to previously, and include the difficulty of apportioning avoided electricity generation to the various power plants with their consequent GHG emissions. While lighting services mostly coincide with the peak periods, it is difficult to say whether a CFL program would reduce generation from gas, pumped storage, coal or nuclear plants, especially when other DSM programs are causing similar effects during peak periods. Assessment of the impacts of the energy-efficient lighting project requires an understanding of the total demand now and in the future, the corresponding lighting demand with and without the lighting program, and the planned generation expansion to meet the future demand. Further research is required to calculate the embedded emissions of pumped storage.

In the housing case, project-specific measurement and assessment challenges arise mainly out of the long-term nature of the project. A monitoring plan has been developed for the proposed project in which data on direct GHG and ancillary benefits would be collected for both baseline homes (the control group) and new Eco-Homes. Household interviews would be conducted, along with collection of data from suppliers of energy services to verify figures given by the households. Documentation of baseline values would begin one year prior to construction of the Eco-Homes to establish energy use within new homes that lack thermal efficiency measures.

After construction of the proposed Eco-Homes, data related to household energy usage and GHG emissions would be gathered quarterly for the first year, biannually for the second and third years, and annually thereafter, with an emphasis on the winter months. Utilizing such rigorous monitoring and verification methods, by enabling long-term tracking and comparison between different types of low-income housing, is expected to alleviate much of the uncertainty related to the 50 year time scale of the project.

3.5 Inadequate Financing and Unknown Macroeconomic Impacts

In the case of the CFL project, if it were presented as a potential JI opportunity, it would be unlikely to suffer from inadequate financing due to its favorable economic returns. Provided Eskom was prepared to share these benefits with investors, it would most likely, in turn, attract investors keen to make the project succeed.

In the housing project, since the government subsidy reimburses the basic housing construction and management costs, the only additional financing required is about $425 per house, or $17 and $13 per ton of C saved in the low and high energy-savings scenarios respectively, for the technical expertise, training and other consultancy investment associated with the thermal efficiency aspects of the project. The few additional costs related to the structure itself (such as the CFLs and wall insulation) all have positive medium to long-term economic returns.

With respect to macroeconomic impacts, the main risk in the case of the CFL program would concern the exchange rate and importation of CFL products. The South African Rand depreciated by some 25 percent in 1996, with the result that balance of payments pressures grew and foreign reserves declined to low levels. Whilst this situation improved during 1997, a CFL program would nevertheless involve the importation of large quantities of the lamps, at least in the initial years, and this would have potentially negative consequences. In the longer term, however, it could be possible to reverse this effect, particularly if foreign (and local) investments were made in local CFL production capabilities, with the potential even for export growth.

A CFL program and the lighting aspect of the proposed Eco-Home project are also likely to have a negative impact on South Africa's incandescent lighting industry. More than half the CFLs are planned for the new demand for electrification, and as such the program will reduce the potential growth of the incandescent industry. Those CFLs, which are planned to replace incandescent lighting in both high- and low-income households, will have an impact on the existing market share of the domestic incandescent lighting industry. The scale of the impact is, however, likely to be small. Due to the longer life of CFLs, the unit sales of CFLs will always be small relative to the sales of incandescent bulbs. To illustrate, it has been estimated that if half the light sockets in the world held CFLs, they would still account for only 5 percent of bulbs sold (Clarke 1997). Having said this, the competition for market share that the domestic incandescent industry will face from imported CFLs may provide a platform for the incandescent industry to lobby for higher import tariffs. Furthermore, the impact of a CFL program on the domestic incandescent lighting industry needs to be weighed against any future potential to establish a local CFL industry. The instability experienced in South Africa's foreign currency markets and foreign reserve holdings during the last few years underlines the importance of these macroeconomic questions.

The issues raised above related to the CFL program are also relevant for the lighting aspect of the Eco-Home project. For housing construction, however, locally-attained suppliers and labor will be used as much as possible, generating long-term economic growth for the community. As for the macroeconomic effects of successful energy-efficient housing development on the standard housing delivery industry, it is possible that other developers may benefit from a trained local work force and regionally-produced materials. Such benefits are expected to bring housing costs down so that energy-efficiency measures will be more cost-effective to introduce (IIEC 1997). Expectations for quality, energy-efficient housing will also likely rise among community members, perhaps putting pressure on other developers to incorporate thermal measures as well.

3.6 Dumping of Old Technology

An important concern emerging out of the African literature on JI is that JI will provide industrialized countries with the opportunity to dump old technology on the developing world

(Maya 1995; Kuik & Gupta 1996; Gupta et al 1996). If the technology provided by the investor country is inferior, then it is likely that the host country will be compelled to replace this technology in the future and the potential benefits of participating in JI will not be realized. South Africa shares the African group position. There is a real concern that South Africa's knowledge of the international market is inadequate and, therefore, its capacity to assess the technology in terms of whether it is state-of-the-art is limited or, at the very least, has to be built up at some cost. To this end, one of South Africa's conditions for acceptance of the AIJ pilot phase, is that it must build capacity in South Africa so that full local understanding of issues relating to the implementation of the UNFCCC via JI is achieved.

Having said this, CFLs have a relatively short life span compared to other capital equipment and this high turnover reduces the risk for the host country. As long as the fittings for CFLs remain the same, South Africa will be able to adopt and promote new, more advanced technologies as they emerge. It must be noted, however, that dumping of inferior quality CFLs is likely to cause irreparable damage to people's perceptions of energy-efficient lighting, jeopardizing the long-term global benefits of the CFL program and the lighting component of the energy-efficient housing development.

Conversely, the thermal-efficient design measures of the Eco-Home project have a relatively long life span of approximately 50 years. In this case, however, the energy-efficient measures proposed are fairly "low-tech," minimizing host country risk since the design measures employed, such as low overhanging roofs and window positioning, will continue to deliver benefits for as long as they are properly maintained. Dumping of obsolete technology is not a concern for energy-efficient housing construction as long as capacity-building takes place within the community. Training both workers and home dwellers about the energy-saving properties of the house is critical to any type of energy-efficient housing project to ensure the long-term CO_2-saving and comfort benefits of the development.

The success of the program is also dependent on the appropriateness of the technology to the South African context. Technologies that are developed in other countries tend to be developed within the socio-cultural context of those countries and may be inappropriate to another setting

(Kuik & Gupta 1996). Eskom's analysis suggests that the higher-priced CFLs with higher specifications are not necessarily the most appropriate for South Africa. There is a need to choose an appropriate CFL technology which balances efficiency, cost and quality, in relation to the specific context in which electricity is supplied in South Africa. This is particularly relevant with regard to the lower-income residential sector in South Africa.

Care must also been taken to design thermal-efficient housing measures appropriate to the needs of the community being served, in this case, a low-income, urban residential area in a temperate climate. The challenge of the proposed Eco-Home project is to employ energy-efficient technology that meets the emissions-reducing and comfort-raising criteria of Guguletu residents, in the most cost-efficient manner possible. Again, a balance between efficiency, cost and quality must be struck, and this can only be done between parties with an in-depth understanding of both the current needs of the community, and the economic, political, and cultural context in which it exists.

3.7 High Technology Costs

Technology costs do not represent a major barrier for potential investors in either the CFL program or the proposed energy-efficient housing project. Although more expensive than incandescent light bulbs, CFL costs would probably not present major difficulties for project financiers. One of the key goals of the Eco-Homes project is to demonstrate that thermal-efficient design measures can be incorporated with minimal additional cost over the RDP housing subsidy allotment.

As far as consumers are concerned, however, the higher capital costs of purchasing and replacing CFL bulbs would almost certainly represent a major barrier to their more widespread use and thus innovative financing schemes would be essential. These could include, as has occurred in other countries, leasing programs or recovery of CFL costs through the electricity tariff over their useful life span (or a shorter period if risks are perceived to be higher). This factor would have to be designed into the project for it to succeed, particularly in the lower-income household sector.

3.8 Sustainability of the Program/Project

The JI project must bring about measurable and long-term environmental benefits related to CO_2 reduction. With the CFL project, the question arises whether households will continue to use CFLs once the program is over. This is dependent on the perceived benefit, availability, cost and associated mechanisms of financing.

The 50-year life span of the proposed energy-efficient housing project promises long-term environmental benefits in the form of GHG emissions avoidance. The question in this case is whether Eco-Home residents will maintain the structure so that its benefits will continue over the life of the project. As indicated in Section 3.2, capacity-building in the form of training workers and home dwellers would encourage, but not guarantee consistent CO_2 savings. Maintaining long-term benefits is dependent on the length of time families live in the homes, available funds for necessary repairs (such as broken windows or weather-stripping replacement), availability of financing mechanisms for rebuilding energy-efficient homes in the case of fire or severe weather damage, etc. Rigorous monitoring of emissions must be conducted and recorded for both the energy-efficient house and standard-built homes to ensure CO_2 savings and to mitigate hidden costs and uncertainties that arise. Should the AIJ phase of an energy-efficient housing project such as the Guguletu development move forward, emissions and efficiencies data collected will be invaluable to determining the feasibility of potential JI opportunities for energy-efficient housing in South Africa in the future.

3.9 Lack of Institutions to Assess, Evaluate and Monitor Projects

At the global level, there is presently no institutional structure, which can monitor and evaluate JI projects. Within South Africa, however, both Eskom and PEER have considerable institutional capacity to play a role in this process. Unlike most electricity suppliers in the region, Eskom has a strong financial position with a large and skilled work force. Given its role as the main local stakeholder in the hypothetical CFL JI project, this is an important advantage. PEER Africa has established a presence in the South African housing sector since 1996, and offers extensive experience in construction management, worker training programs and monitoring/reporting

services. Clearly, however, Eskom and PEER's role would be limited and they could not act as "player" and "referee" simultaneously. Furthermore, JI projects need to be assessed and evaluated not only in terms of their emissions reductions and avoided cost achievements, but also in terms of their technical appropriateness, their social content and their contribution to national development priorities (Asamoah & Grobbelaar 1996). Neither the host nor the investor industry may be the appropriate party to assess or evaluate these components of the projects. There is clearly a need for capacity-building in national governments to ensure that they are able to evaluate projects on this basis.

Responsibility for monitoring the GHG and other impacts of the JI projects once they are approved should be conducted or determined by the project participants, under standard guidelines set by an international body. Energy usage should be recorded for both baseline and energy-efficiency scenarios, and data relating to ancillary benefits collected. Independent, local organizations should be sought to verify the GHG and economic magnitude of such projects prior to assigning credits to interested parties. It is therefore imperative to identify institutions and mechanisms for (a) evaluating the appropriateness of proposed JI projects by the host country, (b) monitoring the GHG and other impacts of JI projects (c) verifying the GHG and economic magnitudes of such projects prior to assigning credits to interested parties.

3.10 Lack of an Acceptance Process for JI Projects

This point is related to the previous one, insofar as there is no regulatory body, which oversees the processing of potential JI projects, and as a governance framework for GHG trading has still to be developed internationally. This generic point obviously applies to South Africa as it does to other JI actors.

As South Africa has only recently ratified the UNFCCC, its procedural mechanisms for evaluating and accepting potential AIJ projects are still in their infancy. As an interim measure, the AIJ Working Group of the NCCC has the mandate from the DEAT to act as the 'clearing-house' for the acceptance of potential pilot phase projects, with input from the broader NCCC. However, no formal criteria exist against which projects can be evaluated and accepted. The AIJ

Working Group is at present guided by the broad criteria set out in South Africa's position statement on AIJ, the most significant of which are that the AIJ projects must dovetail into developmental priorities of South Africa and must bring about real and measurable long-term environmental benefits related to the mitigation of climate change that would not have occurred in the absence of such activities, and that the funding for AIJ projects must be additional to all existing funding and technology transfer. It is clear that these position statements are too broad to allow for the effective screening of AIJ projects. Without a more detailed set of criteria, South Africa runs the risk of adopting a random project approach, which fails to address the country's developmental needs in a sustainable manner.

To reduce the risks to both the investor and the host countries, AIJ projects must be scrutinized by a 'clearing-house' and approved by national government with a clearly defined set of criteria. The institutional culture of consultation and participation in South Africa also necessitates that AIJ be owned and operated by a broad spectrum of involved persons including representatives from Government, research organizations, labor, community, environmental organizations and industry (Asamoah & Grobbelar 1996).

4. CONCLUSION

This section draws out the main institutions, policies and research requirements to implement an energy-efficiency-related JI project in South Africa.

4.1 Institutional Concerns

South Africa already has an interim clearing-house for the acceptance of JI projects in the pilot phase, in the form of the AIJ Working Group of the NCCC. However, the role of this group has not been fully clarified and the lines of authority have yet to be established. To reduce risk to both the host and the investor countries, a formal national acceptance institution must exist, with clear lines of responsibility to both the government and stakeholders.

While the capacity exists in South Africa, specifically in Eskom and PEER, to monitor and evaluate the projects in terms of their costs, benefits and specific environmental impacts, there is a need for a national institution which is not involved in the implementation of projects to evaluate the reported project results and to assess projects in terms of their contribution to national development priorities. There may also be a need to have an independent institution (local or external) to verify the GHG impacts of the project/program.

4.2 Policy

This paper has highlighted several JI/AIJ issues and concerns, which need to be addressed through policy. These include:

Refine the selection criteria for JI projects in order to ensure a programmatic approach that ensures that South Africa's national development needs are met in a sustainable manner.

Build capacity to assess, monitor and evaluate projects in terms of their CO_2 reduction achievements, avoided costs and social development impacts. Specifically, there is a need to develop a pool of professionals who can offer technical support for the monitoring and evaluation of projects and institutions which can assess the project results in terms of meeting national development needs.

Establish policy on credit-sharing. To-date there has been limited debate on the sharing of credits due to the fact that JI is still in its pilot phase and AIJ projects are not credited. Given South Africa's relatively advanced economic position, however, it is necessary for South African officials to start debating and considering the implications of different credit-sharing scenarios.

Establish standardized methodologies for the assessment, evaluation and monitoring the projects to track the 'sustainability' of emissions reductions. The CFL and Eco-Home projects have highlighted some of the difficulties associated with monitoring and evaluating the results of such energy-efficiency projects in South Africa. Methods to determine a scheme for apportioning the avoided electricity generation to different power plants need to be explored in order to determine the extent of emission reduction and the associated costs.

4.3 Research Needs

There are several uncertainties that have arisen in the potential JI/AIJ projects that require further exploration. These include:

- The impact of the 'take back' effect and the extent to which it decreases the total emissions reductions of the projects.
- The viability of a local CFL manufacturing sector in the longer term and the impact of importing CFLs on the balance of payments in the short term.
- The impact of the projects on the local incandescent lighting industry and South Africa's national priority of job creation.
- The real potential for sustained penetration levels after the projects are complete and the impact of this on long-term emissions reductions.
- The embedded emissions of pumped storage.
- The magnitude of transaction costs associated with long-term monitoring and verification responsibilities of a project.
- The stability of the RDP housing subsidy program.
- Barriers to widespread adoption and acceptability of such energy-efficiency measures by local communities and suppliers.

Explicit mitigation of the above uncertainties at the proposal stage of any energy-efficiency project will likely reduce the risk and increase the desirability for potential JI investors.

REFERENCES

Asamoah, J K & Grobbelar, C J 1996. Activities Implemented Jointly (AIJ): The expectations and opportunities of developing countries – South African country study. Department of Minerals and Energy. Pretoria.

Chatterjee, KC & R Fecher 1997. AIJ for India: Expectations, Opportunities, and Strategies, in *Proceedings of Conference on AIJ: Developing Countries*, January 8-10, 1997, New Delhi, India, (in press).

Clarke, A 1997. Compact fluorescent lamps in an international context. Energy and Development Research Centre. University of Cape Town.

Davis, M 1996. South Africa's electrification program: Progress to date and key issues. *Development Southern Africa*. Vol. 13, No 3, pp 469-484.

Eberhard and van Horen, 1995. *Poverty and Power: Energy and the South African State*. Pluto Press: London.

Eskom 1995. *Eskom environmental report 1994*. Eskom. Johannesburg

Eskom 1996a. *SAtoZ: The decision maker's encyclopedia of the South African consumer market*. 1996 Edition. Eskom. Johannesburg.

Eskom 1996b. Residential demand-side management: energy-efficient lighting. Eskom. Johannesburg.

Gupta, J, R S Maya, O Kuik, & A N Churie 1996. A Digest of regional JI issues: overview of results from national consultation on Africa and JI, in RS Maya and J Gupta (eds), *Joint Implementation: Carbon Colonies or Business Opportunities?* Harare: Southern Centre for Energy & Environment.

International Institute for Energy Conservation 1994. High-level Panel Briefs US Working Group of Global Energy-efficiency Initiative on Joint Implementation, *E-Notes*, Vol. IV, No. 3, July-Sept.

International Institute for Energy Conservation 1996. *Housing for a Sustainable South Africa: The Guguletu Eco-Homes Project*. A proposal developed for the U.S. June 1997.

Kuik & J Gupta 1996. Perspectives on Africa and the Global debate on JI, in RS Maya and J Gupta (eds), *Joint Implementation: Carbon Colonies or Business Opportunities?* Harare: Southern Centre for Energy & Environment. Lennon, S J 1996. Personal communication. Eskom Technology Research Manager. Johannesburg.

Maya, R & Churie, A 1995. *Strategic Approach to Joint Implementation: Perspectives for Developing Countries*, Southern Centre for Energy and Environment. Climate Change No. 2. Zimbabwe.

Naud[a], P & I Lane 1996. Residential Demand Side Management Plan. Eskom. Johannesburg.
National Committee on Climate Change (NCCC) 1997. South African Briefing Paper: United Nations Framework Convention on Climate Change Subsidiary Body Meetings, Bonn, 28 July to 8 August 1997.

National Electricity Regulator (NER) 1996. *1996 Electricity supply statistics for South Africa.* NER. Sandton.

Parker, G 1997. *Building South Africa's Future: Joint Implementation for Delivery of Passive Solar, Energy-efficient Housing for South Africa's Urban Poor*. London School of Economics, London.

Rowlands, I 1996. South Africa and global climate change. *Journal of modern African studies.* 34: 1, pp 163-178.

Scholes, B & M van der Merwe 1995. South African greenhouse gas inventory. Report FOR DEA-918 for the Department of Environment Affairs and Tourism. Council for Scientific and Industrial Research. Pretoria.

Simmonds, G & N Mammon 1996. *Energy services in low-income urban South Africa: A quantitative assessment*. Energy and Development Research Centre: University of Cape Town.

Subak, S, Raskin, P & von Hippel, D 1992. National greenhouse gas accounts: Current anthropogenic sources and sinks. Stockholm Environment Institute. Boston.

van Horen, C, Eberhard, A, Trollip, H & S Thorne 1993. Energy, environment and urban poverty in South Africa. *Energy policy*. Vol. 21, No 5, pp 623-639.

van Horen, C & G Simmonds 1996. Greenhouse gas abatement in South Africa's energy sector. In: Mwandosya M., Makundi W., Meyers S. and Wiel S. (eds). Selected papers from the Regional Workshop on greenhouse gas mitigation for African countries, held in Arusha, Tanzania in August 1995. *The Environmental Professional.* Vol. 18 No 1, pp 53-60.

van Horen, C 1996. *Counting the social costs: Electricity and externalities in South Africa.* ÷lan Press and UCT Press. Cape Town.

World Bank 1996. *World development report 1996: From plan to market*. Oxford University Press. Oxford.

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