

# **Improving household energy efficiency in the new South Africa**

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## **1. SYNOPSIS**

The paper describes some energy efficiency opportunities in South Africa to reduce affordability barriers to housing and energy services.

## **2. ABSTRACT**

South Africa has begun a Reconstruction and Development Programme (RDP) which plans to deliver one million new houses and electrify a further 2.5 million. The RDP offers considerable opportunities to reduce affordability barriers to households and the state through improvements in energy efficiency, including the thermal performance of dwellings.

The technical arguments and the investment potential in energy efficiency as an affordability and social equity issue are currently being explored, and the pre-investment feasibility of household energy efficiency improvements at the time of access are being considered. This paper reviews the issues and considers the role which the North can play in assisting improvements in energy efficiency, with special reference to building human resource capacity and to technological leapfrogging.

If South Africa is to benefit from energy efficiency, the following issues need to be addressed now:

- improving the thermal efficiency of low-cost housing at the time of their delivery;
- increasing access to (and making more affordable) more energy-efficient appliances at the time of access to electricity; and
- building capacity to identify and implement energy efficiency options.

These issues should be at the core of a national energy efficiency and affordability campaign.

## **3. INTRODUCTION**

### **3.1 Background - The Reconstruction and Development Programme and Energy Efficiency**

The majority party in the government of National Unity, the African National Congress (ANC), won just under two-thirds of the vote in South Africa's first democratic elections. The ANC's manifesto in this election was the Reconstruction and Development Programme (RDP), a programme which now enjoys almost unanimous support from South Africans, and is being rapidly promulgated. Key goals of the RDP before the year 2000 are the electrification of 2.5 million households and the building of one million low-cost houses.

The RDP embodies a broad framework for reconstruction, which includes building the economy and meeting basic needs. It does not prescribe priorities but provides basic principles and key programmes with which to rank them. The current ranking, as expected, has been weighted towards the speed and visibility of delivery, which may not bode well for reconstruction with long-term objectives, like energy efficiency. The RDP is specific, however, about energy efficiency; in clause 2.7.5 it states:

Energy efficiency and conservation must be the cornerstone of energy policies. This will involve the adoption of least-cost planning approaches; the improvement of dwelling thermal performance; the promotion of energy-efficient appliances; the use of solar water heaters; appliance labelling, and the implementation of time-of-use electricity tariffs. Financial assistance to ensure that households have access to efficient appliances will be essential. (African National Congress 1994)

The realisation of this clause is unlikely to attract local attention in a resource-constrained environment, where competition with priorities such as job creation, access to clean water, an energy source, food and shelter, are likely to take precedence in the short and medium terms.

### 3.2 Scope

The scope of this paper includes a review of some opportunities for energy efficiency in a climate of improving access to formal housing and energy services. It considers opportunities for successful intervention and barriers to these interventions. Finally, it considers some projects which are in a preparatory state, and ways in which the international energy efficiency and environment community could assist South Africans in realising these opportunities.

## 4. HOUSEHOLD ENERGY EFFICIENCY OPPORTUNITIES IN THE NEW SOUTH AFRICA

A vision of how to repair the devastation of the apartheid years is embodied in the parallel emphases of the RDP: building the economy and meeting basic needs. In providing for basic needs there are many opportunities for energy efficiency improvements that would contribute to the affordability and, therefore, the sustainability of the programme; these include effective land use (urban form) planning, appropriate fabric and design of dwellings, and matching household energy services needs with least-cost fuel/energy source and appliance combinations.

### 4.1 Land-use

The effort to separate the different race groups meant that the apartheid system's land-use patterns resulted in sprawling cities: as a recent World Bank mission pointed out, for example, Cape Town, a city of three million people, occupies twice the space of Mexico City, home to ten times the population. Neither are particularly good examples of sustainable cities, but it is clear that in South Africa's cities much can be done to use urban land more effectively. Town and city councils - a level of government not exposed to universal franchise as yet - are among the barriers to releasing land for urban infilling and therefore urban densification.

How the land is zoned (according to use) is a starting point for understanding settlements. The land could be allocated exclusively for serviced sites on which freestanding informal/formal structures could be incrementally built; or it could have mixed-use zoning, and hostels or flats, which are rentable or purchaseable. Accommodation offered to the newly urbanised are commonly such serviced sites or in situ upgrades of existing squatter settlements. This accommodation is typically far from places of work and access to goods and services. Such low density freestanding settlement patterns on the fringes of urban areas adversely affect the transport energy intensity and the quantity of energy required to heat space. Moreover, the energy used for transport contributes to increasingly hazardous concentrations of airborne emissions and expenses to those who can least afford it.

### 4.2 Housing

In 1979 the South African government abrogated responsibility for low-cost housing. The low-cost housing which was subsequently privately built was of an unimaginative standard type that paid little or no attention to place-making, let alone thermal performance; most of such houses, for example, lacked ceilings. Housing standards were relaxed for reasons of first-cost affordability in black residential areas. These areas were poorly planned, bleak housing estates far from the city centres, and soon became overcrowded ghettos that still have no economic heart.

Approximately 20% of South Africa's 40 million inhabitants are homeless. This translates into a housing backlog of 1.3 million units growing at the rate of 130 000 units per year. In addition there are 1.7 million shacks. The cumulative need therefore is for 5.6 million dwellings within the next 20 years.

The thermal performance of low-cost housing built by the government and the private sector has been hitherto ignored. Low-cost houses are often cold, damp and smoky, and are known to be unhealthy. Particularly common are illnesses of the upper respiratory tract which are the second highest cause of infant mortality, in South Africa. Total suspended particulates (TSPs), associated with the burning of solid heating fuels, have been measured at between five and ten times WHO guidelines for 'lowest-observed-effect-level'. Most vulnerable to diseases of the upper respiratory tracts are women and children. The total direct healthcare costs and loss of productivity related to respiratory diseases has been estimated at R700 million for 1994 alone. If this is added to the long-term costs, the figure could be as high as R1 050 million (National Electrification Forum 1994). While not all of these costs are

attributable to poor thermal design, epidemiologists and advocates of low-smoke coal conclude that improved thermal performance could significantly reduce heating needs and hence mitigate these effects.

Micro-climate conditions such as wind and sun have also been ignored in low-cost housing design. In addition, building forms such as attached and multi-family dwellings have been overlooked in favour of freestanding houses. The affordability of these is further reduced by their distance from places of work. Ignoring end-user needs and preferences has resulted in tensions between those who build low-cost houses and those who live in them. The new government has made a major commitment to low-cost housing and has introduced a housing subsidy scheme which suggests that the:

most critical need is to ensure, through State intervention, affordable access for the poor to a minimum acceptable standard of housing and necessary services within the context of both fiscal and other resource constraints. (Department of Housing 1994a)

The inclusion of minimum thermal performance standards of low-cost housing could be addressed within this context, though it is early days yet:

In respect to electrification, insufficient attention has been paid to the relationship between the thermal efficient qualities of housing, and the generating needs with the energy sector. For example, the provision of basic insulation, including the insulation of ceilings, can have real and quantifiable beneficial impacts on our society. This is at the point of consumption as well as at the point of production. (Department of Housing 1994b)

### 4.3 Household energy services

Coal provides 80% of South Africa's primary commercial energy and is used to generate 93% percent of Eskom's electricity. Buildings use 22% of South Africa's primary energy, and 30% of the electricity consumption is attributable to the domestic sector despite only 40% of households being electrified. Both of these figures are increasing. Direct space-heating and cooking using coal stoves consume 2% of South Africa's coal.

The most basic energy services -- such as lighting, heating and cooking -- consume a high percentage of a low-income household's monthly budget (measures of up to 26% and 38% of the incomes of the rural and urban poorest respectively) (Williams 1994). The affordability constraints of these energy services contribute to poverty and the inability to satisfy basic human needs. Improved energy performance of housing and services could reduce service arrears and housing loan repayment defaults.

The RDP promises to electrify 2.5 million households at the same time as the one million low-cost houses are delivered. These developments will rapidly transform South African's urban environment and increase the consumption of, and demand for, electrical energy for domestic energy services, which would include the heating of homes.

Until recently in South Africa there has been very little incentive for utilities to become involved in efficient end-use or conservation of their product. This is partly because there is limited interest in conservation of energy per se within the energy industry, but more generally because there is a limited energy conservation culture in South Africa, except perhaps amongst the poor, who within the constraints of access to more efficient technologies and information use energy efficiently (Thorne 1994). For this reason the poor, who will be gaining access to electricity for the first time, may make excellent partners in developing energy efficiency programmes.

It is clear that there is no one fuel that will provide all energy services at the least-cost. In examining the major household energy consuming services such as cooking, space and water-heating, lighting and refrigeration, it becomes apparent, however, that some fuel and appliance combinations are better than others in life-cycle cost terms. The minimum life-cycle costs coincide, with few exceptions (such as heatpumps), with the highest energy efficiency (Thorne 1994). Below consideration is given to the most energy intensive services -- cooking, water and space-heating.

#### 4.3.1 Cooking

In South Africa the largest proportion of household energy is provided from the burning of wood (National Energy Council 1990). Fuelwood is used predominantly for cooking and space-heating in rural areas. Urban households prefer electricity for cooking. Liquefied petroleum gas (LPG), while convenient and clean, is not popular as it is

perceived as dangerous by many. Paraffin (kerosene) tends to be used by those urban and rural households without access to electricity or coal for cooking and by those experiencing wood scarcity; it is not a preferred fuel, but is widely used as it is readily available in affordable quantities. Paraffin cooking is a limited to 'top-of-the-stove cooking'. Coal and wood (where they are easily available) provide the least-cost cooking solutions. For other fuels there is little difference in the cost of the service to the end-user. It therefore appears that there is little opportunity in South Africa to improve the energy efficiency of cooking considerably. Opportunities for improvements are more apparent in other energy services.

#### *4.3.2 Water-Heating*

Water-heating is predominantly achieved through the use of cooking appliances in South Africa; hot-water geysers are not widely used by the poor. Solar water heating is not used extensively despite the solar energy potential in South Africa being one of the best in the world (average energy incident per square metre per day is between 4.5 and 6 kWh). This could be attributed to the youth of the solar water-heater industry in South Africa, the cheapness and convenience of other fuels and lack of confidence in the technology. A further barrier to solar water heaters has been that some local authorities, with interests in both planning and electricity sales, require developers to guarantee levels of electricity consumption prior to providing electricity to a new site. The arrangement between the authority and the developer provides sufficient disincentive to the installation of water-heaters other than those fuelled with grid electricity.

Electric water-heaters are estimated to constitute 40% of South Africa's domestic electricity load, and are predominantly. Currently there is an estimated 4.8 GW of geyser under demand which can be shifted in times of peak demand (Ligoff 1992). Some municipalities practice ripple control of geysers to manage this load. The potential for LPG and electric in-line heaters in series with solar pre-heaters is being explored, as this could deliver energy efficiency and the convenience of heated water when there is little solar power. A problem associated with a combination of solar and electricity is that the coldest day of the year in the most populous area is generally overcast, suggesting that the peak demand for electric space- and water-heating could easily coincide.

#### *4.3.3 Space-Heating*

In South Africa space-heating is required for the maintenance of healthy and comfortable conditions for several months of the year, particularly in the most populous areas of the interior and also the western and eastern Cape coastal regions. The diurnal and seasonal temperature fluctuations result in temperatures which drop below zero inland, while temperatures along the coast are milder, although higher humidity results in damp conditions there affecting health and the fabric of dwellings. In these climatic zones, active heating is typically achieved by burning fuels like wood, coal, paraffin and LPG, and through using electrically powered heaters. By introducing roof insulation and low-tech solar thermal design features, most active space-heating could be eradicated; moreover, greater comfort during hot weather could be achieved. In larger housing units such as hostels and multi-storey flats, heat-pumps would provide an affordable space heating option.

#### *4.3.4 Other energy services*

Lighting and refrigeration, while not large energy demanding services, are important to the quality-of-life. The most efficient lighting and refrigeration option is undoubtedly electrically powered. Lighting consumes a large proportion of poor households' energy expenditure. While fluorescent tube lighting is popular in South Africa, there are limited applications of compact fluorescents. Where there is no access to electricity, candles and paraffin lamps are used.

The important role of refrigerators in the storage of medicines and vaccines, has contributed to the rural electrification drive in South Africa. Refrigerators are popular appliances in newly electrified areas, which after lighting, televisions and cooking appliances, have rapid penetration rates. Levels of up to 90% penetration have been recorded after a period of 3 to 4 years access to electricity (Thorne & Qangule 1994).

## **5. INSTITUTIONS**

### **5.1 Eskom**

Eskom, the national electricity utility, is a parastatal that borrows on local and international capital markets. Eskom has a rapidly decreasing overcapacity as a result of widespread electrification<sup>1</sup>: recently it has been reported to have approached within 40 MW of available capacity (Surtees 1994). De-mothballing of older plant is underway, in

conjunction with the commissioning of the first half of nearly 3.6 GW of plant (Majuba), the purchasing of several potential nuclear sites on both east and west coasts, the possibility of buying hydro-electric power from Zimbabwe and Mozambique, and talk of a regional power-pool. So far Eskom has shown little real interest in improving the efficiency of energy services.

Eskom has, nevertheless, embarked on a modest triple-strategy DSM project with load-shaping objectives (Eskom 1994), including:

- ripple control of electric hot water storage geysers;
- time-of-use tariffs; and
- interruptible tariffs.

None of these will directly affect the newly electrified. This no-regrets beginning to DSM (or what Eskom calls 'integrated electricity planning'), initiated by their pricing policy department, is directly pitted against Eskom's powerful electricity marketing department's electrowise programme with its planned penetration of electrical appliances, that included resistance heaters, until mid-1994. In other words, DSM -- yes, end-use energy efficiency -  
- no.

Under new chief executive Alan Morgan, however, Eskom's mission" has been reinterpreted and there appears to be growing principled interest in energy efficiency: Eskom now seems willing to contribute towards energy efficiency policy projects, although offers are likely to be limited to research contracts until they are supplemented by the presence of resources from elsewhere which could encourage and facilitate implementation in South Africa.

## **5.2 The municipal distributors**

The 350-plus electricity distributors (mostly municipalities) are grouped into an umbrella organisation, the Association of Municipal Electrical Undertakings (AMEU), which could be more interested in integrating energy and other municipal reconstruction objectives, particularly when municipalities are democratised. Further, the AMEU's limited and/or obsolete generating capacity exposes them to an Eskom tariff which is related to consumption and demand. Recently the AMEU has suggested that it is, in principle, interested in DSM and energy efficiency.

## **5.3 The Department of Mineral and Energy Affairs**

Of all the main institutional players, the Department of Mineral and Energy Affairs, appears to have been the most positively disposed towards energy efficiency: it has a commitment to see energy efficiency encouraged in South Africa. Its role, despite being the clearing house for enormous subsidies for the Atomic Energy Commission, is limited to research contract funding and policy formulation -- not implementation. It could still play a big role in influencing government procurement and facilitating the establishment of strategies to intervene in the setting of standards, and the provision of incentives for utilities, builders, and energy-consuming appliances.

The Department may have the will to see energy efficiency implemented in South Africa; however it is extremely small in terms of person-power and budgets when compared to the utilities, and has little chance of effectively changing their practices, unless more effective governance is established through the infant National Electricity Regulator. But it may be ill-advised to hope for too much even if least-cost energy planning is a regulatory goal as the regulator is to be chaired by the former Chief Executive of Eskom, and the head of the regional power pool initiative.

## **5.4 Oil and coal companies**

In South Africa, oil and coal companies appear to have little incentive to improve energy efficiency. The oil companies have, however, been working on improving the distribution network for paraffin and reducing the health risks posed by its ingestion, while their LPG merchants are expending much effort in attempting to change the widespread opinion that LPG is dangerous. This is a sign that they may be willing to promote themselves through social investment, in which case improved thermal performance of housing could be interesting to them.

## **5.5 Builders and the houses they build**

The government abrogated responsibility for housing in 1979, and left it to the 'low-cost housing market'. Construction companies applied to local authorities for housing standards to be waived so as to build houses that have

low first-costs. Formal low-cost housing, where available, is of poor quality and low thermal performance. Much of the low-cost housing stock therefore, for example, lacks ceilings.

The government Housing Subsidy Scheme offers a chance to reduce the tension between those who build houses and those who live in them. To qualify for the limited subsidy (R15 000 for the poorest), social compacts between stakeholders in the housing project have to be concluded. This would specify how the subsidy is to be spent. Technically it is feasible and, with a 50% rate of unemployment, desirable that people could build their own houses, and earn the subsidy.

The Departments of Housing and Mineral and Energy Affairs have recently endorsed a proposal to the Global Environment Facility to pilot low-cost thermally efficient houses, in order to find the macro-economic optima between housing, energy, health and the environment (South African Government 1994). With an estimated 5.6 million dwelling units required in the next 20 years, the time to retrain builders to build houses with lower life-cycle costs could not be more opportune. Providing an incentive for the recipients of the housing subsidy and demonstrating the possibilities may assist in getting potential home-owners to choose improved thermal performance.

## **6. APPLIANCES, STANDARDS AND PROTECTION**

Electrical appliances have been manufactured and marketed with the assistance of some 30% protection (for white goods and more than double that for brown goods), benefitting the middle-to-high income sector. As part of the electrification drive, however, cheap highly energy-consuming appliances have been provided at the time of electrification to the poor in an effort to promote the consumption of electricity.<sup>13</sup> Appliances in this category include two-plate hot plates, electric kettle urns, and irons.

The South African Bureau of Standards (SABS) offers the option of its mark for appliances which meet certain standards. Appliances are currently not labelled as to their energy performance, and the only mandatory standards are those prescribing safety. For non-electric appliances there are few standards.

A more pressing issue is the exposure South Africa faces with respect to the dumping of substandard equipment excluded from northern markets. Strategies which attempt to make use of the retooling assistance provided through international protocols and conventions urgently need to be developed. Such strategies will require the voice of the National Union of Metal Workers of South Africa (NUMSA), a union which is part of the Congress of South African Trade Unions (COSATU).<sup>14</sup> The capital side of this industry appears to neither know about affordability, in life-cycle terms, nor be keen to retool, for greater efficiency.

## **7. LOCAL CAPACITY**

In South Africa there is little local human resource capacity to implement a national energy service efficiency and affordability campaign outside of Eskom. For such a campaign to be sustainable, local human resource capacity, and particularly that of women and black South Africans has to be built. To transfer to South Africans the ability to identify, analyse and implement energy efficiency opportunities should be integral to all components of a campaign. The lack of local expertise is therefore considered a barrier. However, regional programmes to develop industrial and commercial energy auditing and implementation skills, and a pan-African agreement to use local expertise, may yet allow for a growth in capacity.

## **8. CONCLUSIONS**

The barriers to improving the energy efficiency of household energy services are, as everywhere, institutional, human and financial resources. South Africa already has a high energy intensity which could be exacerbated, exposed as it is with reduced tariff protection, and no performance (other than safety) standards in place. Similarly, Eskom's much-publicised policy to make available the lowest priced electricity may result in South Africa attracting more energy-intensive mineral beneficiation.

Electrification and housing are likely to be the most clearly visible infrastructural upgrades that the Government of National Unity will be able to deliver, in fulfilling its objective of meeting basic needs -- for example, access to electricity was gained by 350 000 households in 1994, a figure which is likely to reach 450 000 in 1995 and 500 000

thereafter. However, in the rush to be seen to be delivering election promises in the form of houses and electricity, energy efficiency opportunities exploited at the time of access could well be overlooked.

Projects are required to improve the thermal efficiency of housing, to get energy-efficient appliances into the homes of the poor, and to build the human resource capacity to analyse and implement. Currently project proposals exist in all of these areas for example, a project pending with the Global Environment Facility entitled Improving the thermal performance of low-cost housing in South Africa (mentioned above), plans to pilot and monitor thermal performance improvements. These are unlikely to enjoy much local support, however, in a South Africa which is constrained by high levels of competing demands for limited financial resources, with the first-cost of the delivery of basic needs receiving higher political interest. The fact that incremental first-cost differences between efficient and inefficient apparatus may be small compared to the life-cycle benefits, appears to be not yet part of the planning equation.

Interest from the international energy efficiency community can assist in capturing opportunities in the following ways:

- providing examples of relevant national economic and end-user savings, job creation potential, and environmental benefits;
- locating carefully directed financial resources; and
- contributing to training strategies for South Africans.

The international energy efficiency community could consider finding resources for projects in South Africa areas, and ensuring that gains in their own countries do not translate into losses in others. Such losses could include the export of sub-standard equipment or energy intensive industries, as these would negatively impact on the ability of countries like South Africa to undergo market transformation through technology leapfrogging, and meet commitments related to climate change.

## 9. ENDNOTES

1. Electricity reached 350 000 homes in 1994, and is expected to reach rates of half a million by 1997.
2. Provide the means by which customers 'needs are satisfied in the most cost-effective way subject to resource constraints and the national interest (Eskom 1993).'
3. Electricity distributors argue that in order to recover the costs of electrification, consumption has to be increased. The tariff structure is such that the price of connections are nominal with the remaining cost being collected through the tariff.
4. COSATU is part of the tripartite alliance with the ANC and the South African Communist Party which won the 1994 elections.

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<sup>i</sup> Electricity reached 350 000 homes in 1994, and is expected to reach rates of half a million by 1997.

<sup>ii</sup> 'Provide the means by which customers' needs are satisfied in the most cost-effective way subject to resource constraints and the national interest (Eskom 1993).'

<sup>iii</sup> Electricity distributors argue that in order to recover the costs of electrification, consumption has to be increased. The tariff structure is such that the price of connections are nominal with the remaining cost being collected through the tariff.

<sup>iv</sup> COSATU is part of the tripartite alliance with the ANC and the South African Communist Party which won the April 1994 elections.