

Final Draft

**ENERGY EFFICIENCY AND DEMAND SIDE MANAGEMENT IN
SOUTH AFRICA**

The urban poor household sector

By

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SUPPLY-SIDE ENERGY EFFICIENCY INTERVENTIONS

3.1. Introduction

This chapter reviews the current practices of energy suppliers with respect to energy efficiency and demand-side management. Suppliers' application and policy-makers' contribution to energy efficiency measures are also examined.

3.2. Eskom's IEP and RDSMP

Eskom, the largest supplier of electricity to residential households in South Africa, defines *integrated electricity planning* (IEP) as a 'process which aims to reduce the cost of electricity by selecting an optimal mix of demand-side and supply-side programmes with which to satisfy customers' needs' (Eskom 1994). Eskom employs Residential Demand Side Management Programmes (RDSMP) as a tool of IEP. Demand side management was defined in chapter one of this paper as 'a supply authority management scheme, which is end-user informed' (Thorne 1995: 96).

The objectives of Eskom's RDSM include the following (Ligoff 1993: 2):

- optimising the utilisation of surplus capacity;
- sustaining the decrease in the real price of electricity in the long term;
- increasing electricity's competitiveness in the small customer energy market;
- contributing towards the national economy; and
- contributing towards environmental conservation and awareness.

Eskom essentially adopted DSMP as a means of reducing the demand on the electricity load at peak time (Eskom 1995: 16). Its current RDSM programmes are outlined below.

- Time-of-use tariffs (TOU)

This is a time-differentiated pricing structure which can be used to extract the desired market response from small customers or residential households.

- Water heating load management

Water heating typically constitutes about 40% of a domestic load (Ligoff 1993: 17). This end-use is often seen as having the greatest potential for load shifting since electric water heaters do not have to be switched on at the time of use.

Eskom has four sub-programmes associated with water heating load management. These include:

- Promotion of appropriate hot water usage

The intention of this programme is to promote appropriate water heating systems which are available in the country at the moment such as efficient shower heads and so on.

- New geyser design

New geysers are to be designed and marketed to take into account TOU tariffs, extended ripple control switching and solar heater adaptation.

- Solar water heating

This programme is aimed at developing and marketing cost-effective solar water heating in conjunction with electric water heating systems.

- Heat pumps

The intention of this programme is to develop and test cost-effective heat pumps and to market these as efficient water heating systems.

- Appliance labeling

This programme aims to create an awareness among customers of the relative running costs of appliances. Eskom intends to rate appliances in terms of their relative energy efficiency. Initial appliances targeted include fridges and freezers.

- Thermal efficiency

Eskom's load research has shown that the demand of low-income communities is particularly sensitive to changes in temperature with space heating constituting a major component of the after diversity maximum demand (ADMD). This contributes directly to both morning and evening peaks.

- Efficient lighting

This programme of Eskom's intends to promote the use of compact fluorescent lights as well as other efficient lighting sources.

- Combined DSM programmes

Figure 3.1 provides an indication of the impact on a domestic load profile given the combined DSM programmes.

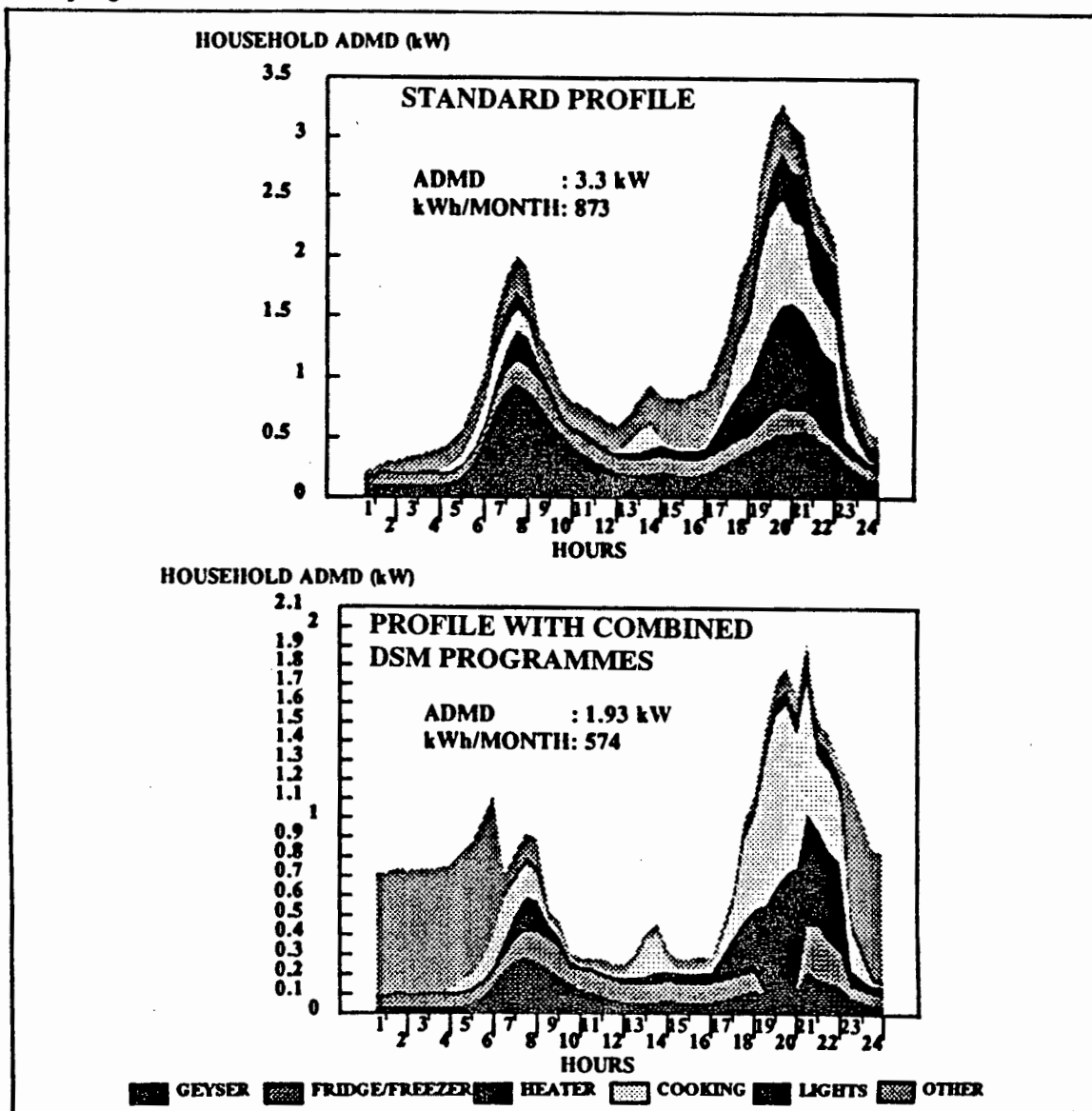


Figure 3.1 Impact on a domestic load profile in response to the combined DSM programmes

Source : Liggoff 1993

3.2.1 Eskom's energy efficiency funding

Eskom's five year funding commitment of R238 683 000 to research between the years 1994 and 1998 includes an allocation of R2 million (2.2%) to energy management systems where the focus is on energy efficiency and conservation (Eskom 1993). In the current year (1995) an amount of R630 000 has been allocated to the thermal performance of dwellings and adequate and affordable energy services for the urban poor (Eskom TRI 1995).

3.3. Local authorities' application of DSM

Local authorities in South Africa utilise DSM in a very limited way. Their motivation is somewhat similar to that of Eskom's, that is to reduce the demand on the electricity load at peak time.

- **Ripple Control**

This involves the direct control of hot water geysers by switching them off at peak times. This measure is popular with municipalities because of the direct economic benefits the municipality derives through the improvement in load factor and the reduction of the purchase cost of power from Eskom (Anderssen and van der Merwe 1989: 88).

- **Tariffs**

Time-of-use tariffs are mainly utilised by municipalities in South Africa to affect demand. Where tariffs are used, they are based on marginal cost, time-of-use and time-of-day. Others are specifically designed to alter the load shape of the municipal supplier. According to Anderssen and van der Merwe, the use of tariffs is rarely employed to 'influence user behaviour and to improve load factor' (1989: 90).

- **Communication**

In some instances there is an attempt by municipalities to communicate with customers about the most efficient way of using electrical energy. This usually takes the form of a newsletter accompanying the customers' electricity account. The account itself, however, does not explain in any great detail to the customer how electricity is utilised and how savings could be made. Electricity accounts are generally set up to suit the needs of accounting departments within municipalities rather than the customers they serve.

- **Load shedding relays**

Municipalities are known to discourage their customers from the simultaneous use of stoves and hot water cylinders. These are often also communicated in a newsletter which is often not the most effective means of communication. The effectiveness of this strategy has neither been measured nor documented by municipalities.

- **Pumped storage scheme**

Anderssen and van der Merwe (1989: 93) report that the Cape Town City Council operates a successful pumped storage scheme at Steenbras which ensures a very high Eskom load factor.

3.3.1 Energy efficiency funding - local authorities

Figures 3.2 and 3.3 represent the typical format of the expenditure accounts of two of the largest local authorities' electrical engineering departments in South Africa, namely Cape Town and Johannesburg. Funding towards energy efficiency programmes is not specified and if included in the category 'other' in the case of Cape Town, constitutes only a minute percentage of this department's expenditure.

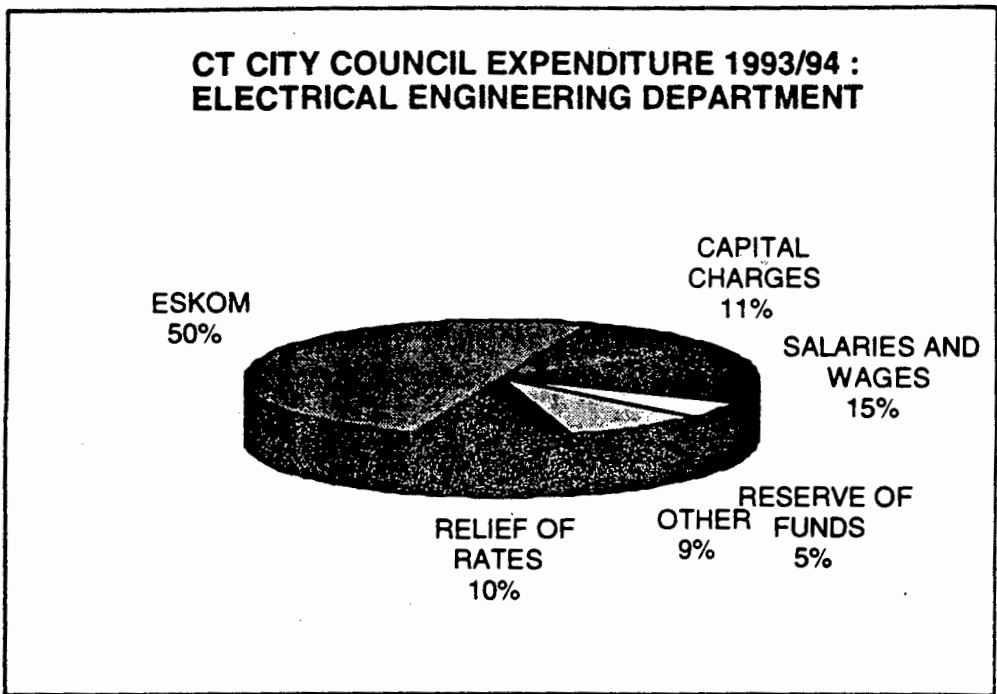


Figure 3.2 Cape Town City Council Electrical Engineer's Department expenditure (1993/1994)

Source: Cape Town City Council Electrical Engineer's Department's Annual Report (1993/94)

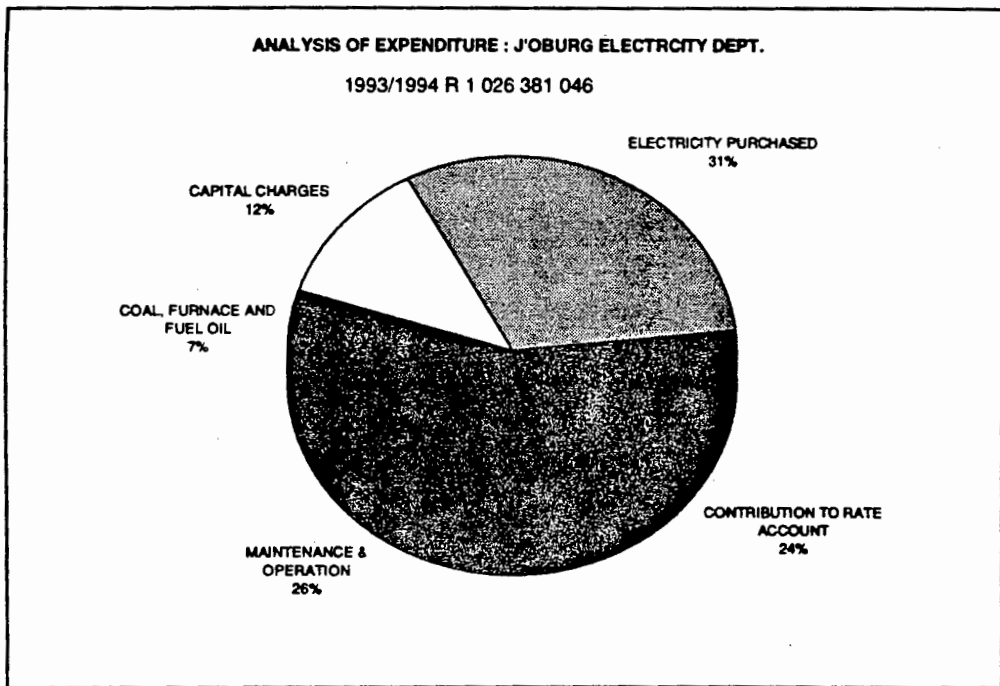


Figure 3.3 Johannesburg City Electrical Engineer's Department expenditure

Source: Johannesburg City Electrical Engineer's Annual Report (1993/94)

There is no indication in the literature surveyed that local authorities take account of thermal comfort when they construct housing developments for low-income households.

3.4. DMEA, energy efficiency and funding

The Department of Mineral and Energy Affairs' Energy for Development directorate supports policy research projects on energy efficiency to inform its policy making. For example, it introduced a manual containing guidelines for housing boards which contain thermal comfort

considerations. Some of its other work on energy efficiency in the urban household sector is incorporated into the major studies reviewed in chapter 2 and listed in the bibliography.

There is currently very little explicitly stated national policy on energy in housing development including considerations about thermal performance. Minimum standards through regulation governing planning and development of formal housing are generally applied.

This department is, however, largely responsible for providing funding for research in the area of energy efficiency in the low income urban household sector. Figure 3.4 indicates that the budgetary allocation for this department is R716 374 000 for this year. It forms roughly 0.2% of the total government expenditure account for the current financial year.

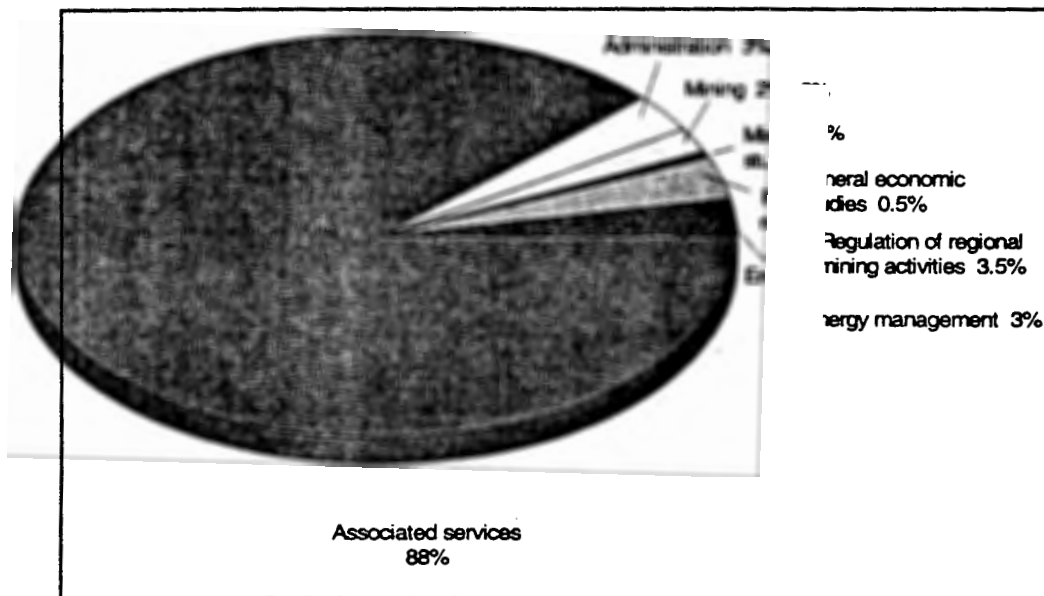


Figure 3.4 Department of Mineral and Energy Affairs budget allocation - 1995/96

Source: Department of Finance (March 1995)

The most noticeable feature about the DMEA's budget is its huge allocation to 'associated services' which is undefined in the public information available on budgetary allocations for the current fiscal year. The DMEA, however, confirmed that 68% of the 88% allocated to this category goes towards nuclear energy. It was further confirmed that of the 68%, R311 million is a direct subsidy to the Atomic Energy Corporation (AEC).

Only 3% of the DMEA's budget is allocated to energy management which refers to the department's research funding commitment to ensure the optimal utilisation of energy sources. Figure 3.5 depicts the breakdown of the department's expenditure on energy management, the largest share of which goes towards electricity (34.5%). This portion is allocated to research into electricity and gas (8.54%), energy efficiency and coal (25.58%), energy and environment (65.86%).

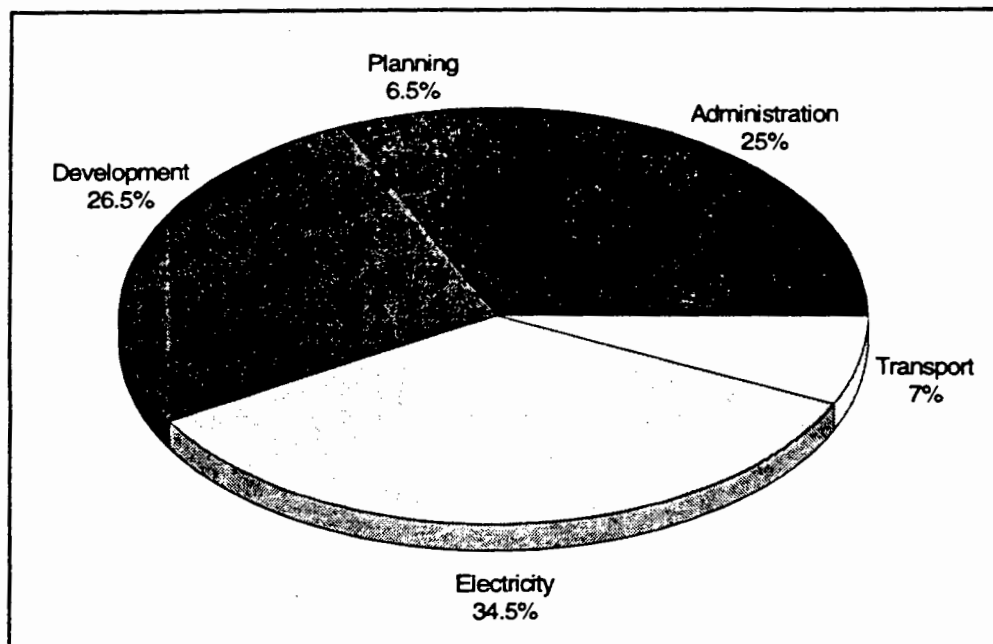


Figure 3.5 Breakdown of DMEA energy expenditure for 1995/6

Source: DMEA (1995)

3.4.1 Energy policy white paper (Energy Policy Discussion Document)

This purpose of this document is to provide a systematic framework for government, energy suppliers, users and other stakeholders to participate in dialogue around a new energy policy directive for South Africa.

The document covers energy efficiency in the following areas:

- the development of an energy efficiency agency within the Department of Mineral and Energy Affairs;
- the promotion of energy efficiency by the state through the development of knowledge and information on sectors and applications where energy is used inefficiently;
- the introduction of energy efficiency into state buildings and facilities;
- the establishment of a national programme aimed at improving the thermal performance of low-cost housing;
- the improvement of appliance energy efficiency through the application of minimum standards, establishing appliance norms and labeling and introducing import barriers based on appliance performance standards and norms; and
- the control of hot water geyser systems.

The areas considered in the Energy Policy Discussion Document no doubt cover a wide range of issues pertinent to energy efficiency. These will be evaluated in the following chapter.

3.5. The National Electrification Forum (NELF)

NELF was a forum of non-statutory and statutory stakeholders investigating a range of policy issues with a view to increasing the rate of electrification of the household sector.

NELF's working group for the end-use of energy and the environment produced a number of working documents in 1994 to consider the provision of domestic energy services, particularly electricity, to end-users. The focus of this group was the satisfaction of domestic energy service needs at lowest life cycle cost.

The reports produced by this working group included the following.

3.5.1 The use of energy and equipment

This study investigated the use of equipment, including characteristics and affordability, the mix of energy carriers and the consumption, cost, availability and affordability of energy to users.

The policy issues identified include gender considerations, the importance of energy for thermal applications, the unraveling of the benefits and disadvantages of each of the multiplicity of fuels used by households and addressing the problems associated with the acquisition of appliances.

3.5.2 Domestic electrical appliances

The electrical appliance manufacturing industry's output for 1993 amounted to R2.1 billion. Equipment of completely built up units worth R700 million and component parts worth R500 million were imported for this period. Exports represented R75 million. It is estimated that approximately 15% of total appliance sales were a direct result of new electrification programmes (Basson 1994). This will, however, change over time.

Two salient points mentioned in this work are firstly, the lack of consumer knowledge among new and potential consumers about electricity usage, appliance availability, prices and quality differences and secondly, first time affordability, high life cycle costs and cost of credit.

3.5.3 Passive/thermal design and heating of dwellings

Concern was expressed about the poor thermal performance of dwellings occupied by low income households. The life cycle cost of heating a dwelling with poor thermal performance is much higher than one with good thermal performance. Thermal performance of existing low-income dwellings can be considerably improved through retrofitting measures.

The existing use of specific energy carriers for space heating, especially coal in the inland urban areas of the country, leads to unhealthy environmental conditions inside and outside the dwelling. It is estimated that the health costs associated with the use of this energy carrier for all end purposes, including loss of productivity, is very high.

Health costs can be reduced significantly through passive thermal design and retrofitting.

3.5.4 Demand profiles and their influence on electrification strategy

Basson (1994) outlines the nature of township electricity demand profiles and studies associated with these. The present impact of these profiles is quantified and future projections are made based on growth estimates of the various sub-sectors within the South African domestic customer base.

The impact of end-uses on the demand profile and the potential for some DSM initiatives within the domestic sector are also evaluated.

3.5.5 Energy and environment interface

This report summarises 'the environmental impacts of electrification and details a holistic environmental management approach which may be adopted in a national programme such as electrification' (Basson 1994). Important national impacts of electrification are identified along with weaknesses and gaps in the current processes associated with the provision of this service.

Integrated environmental management (IEM) was evaluated and said to be inappropriate for electrification. It was therefore concluded in this work that 'subject to the implementation of appropriate management systems, electrification will result in net positive or neutral local, regional and global environmental impacts' (Basson 1994).

3.6. The National Electricity Regulator

The National Electricity Regulator (formerly known as the Electricity Control Board) which was established in 1995, represents a wide spectrum of stakeholders and implements public policy for the electricity sector by issuing licenses for the distribution, transmission and generation of electricity in South Africa. It has the power and mechanisms to determine conditions of supply and set tariffs.

It does not, however, engage in any energy efficiency measures at this stage and requires a clear policy directive on energy efficiency to be provided by government (Steyn 1995: personal communication).

The Electricity and Eskom Acts are the main pieces of legislation governing electricity generation and distribution in South Africa. Energy efficiency is not at all mentioned in either of these governing measures.

3.7. Oil and coal companies

Thorne (1995: 49) points out that oil and coal companies have very limited interest in promoting energy efficiency measures, especially in the household sector since their direct interest lies in increased sales. In any event, the household sector makes a minute contribution of these companies' sales.

3.8. Mortgage lenders

There is no explicit commitment from mortgage lenders to provide low-income housing borrowers with incentives to consider the thermal comfort of their dwellings at the point of construction or in retrofitting measures in the case of already existing mortgage holders.

It is estimated that R7.5 billion per annum will be required to construct 300 000 homes in order to address the backlog in the provision of housing in the country (de Blanche 1993). This size of this potential market may well lead mortgage lenders to consider thermal comfort as part of the financial package offered to low-income housing borrowers.

3.9. Builders

Thorne (1995) points out that a survey of 121 building contractors revealed that 70% seldom or never take energy efficiency into account in the design of structures. Figure 3.6 points out the respondents' reasons for this.

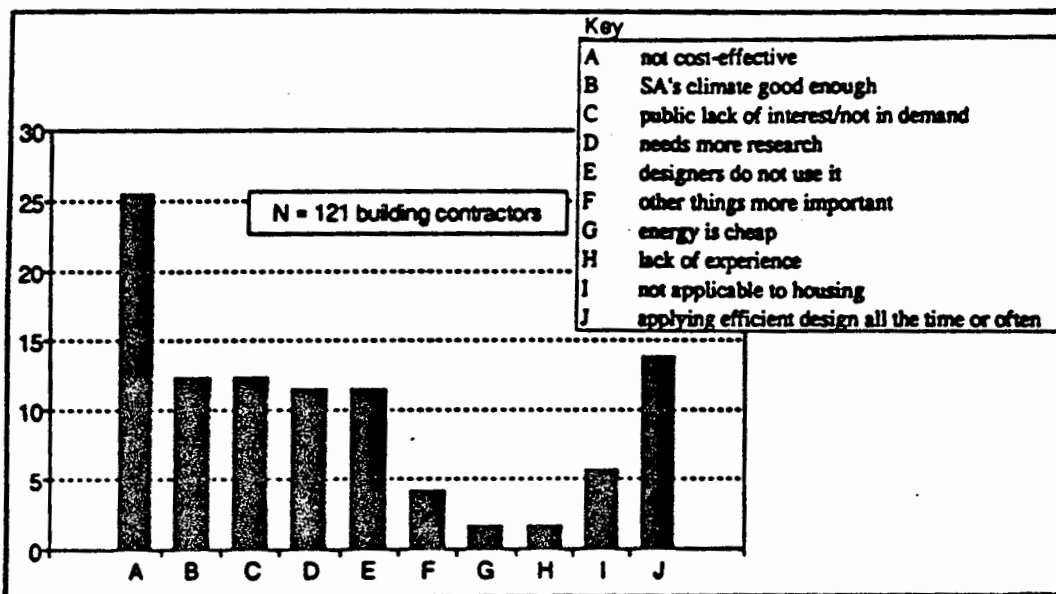


Figure 3.6 Builders' reasons for seldom or never using energy efficient design
 Source: Lewis (1993)

ANALYSIS OF ENERGY EFFICIENCY MEASURES

4.1. Introduction

It was stated earlier that *integrated energy planning* (IEP) demands that the energy sector be integrated with the social, economic, political, environmental and spatial sectors. It was also asserted that demand analysis requires an understanding of the relationship between energy demand and other variables so that it can adequately inform DSM practices.

Chapter three of this paper reviewed the management tools employed by suppliers and the contribution made by various stakeholders to energy efficiency practices in South Africa. This chapter critically analyses these practices in terms of their application to the focus group of this paper.

4.2. Redefining IEP

IEP may be a sound methodology or process within which energy policy planning and implementation takes place since it endeavours to incorporate those sectors mentioned above. However, when it is applied to the assessment and understanding of energy efficiency in the urban poor household sector, it is clear that the economic (including technology) and political sectors prevail. While the importance of these sectors is not to be denied, IEP would offer more if these were integrated with environmental, social and spatial considerations as well. In theory, IEP should consider all these sectors (Eberhard 1994). However, this does not happen in the practical application of IEP.

The fate of the energy needs of the poor in South Africa is largely determined by information and data sources which are predominantly based on economics and politics. Macro economics and national demographic data sources are the main informants of energy policy making. Energy end-use, fuel consumption patterns and energy efficiency in this sector are analysed in terms of these data sources and while there is a place for the use of such data, there is no indication of what real economic benefits there might be for the individual household in the urban poor sector i.e. micro economic effects.

Furthermore, at a broad level, IEP contains elements of the basic needs approach. However, from a political point of view the basic needs approach has been disparaged because it fails to address the unequal power and gender relations at the household level (Makan 1994: 5). Furthermore, it is argued that 'the tendency in research to look *at* households rather than *inside* them, ignores important intra-household dynamics such as gender and the implications they have on power and control over resources' (Moser 1993 cited in Makan 1994).

Where smaller scale local area research has been conducted such as the study in Cape Town by Thorne and Qangule (1994), the focus is on end-use and consumption patterns rather than sketching a holistic picture of energy as a component of the effective operation of a local urban area. In other words, the question of what should be done in order to overcome the development problems in this area or region and how should the energy input be arranged to contribute effectively to that process, remains unresolved.

As observed in chapter three of this paper, the DMEA's budgetary allocation is largely informed by macro-economics and politics. It was stated earlier that self-sufficiency and sustainability in energy resources has historically been a high priority for South Africa. The large discrepancy in the allocation of funding between the Atomic Energy Corporation, for example, and energy management which includes funding for research on energy efficiency and electricity, would be

adjusted and re-prioritised if based on an approach true to integrated energy planning i.e. taking account of all sectors of development. Energy efficiency and the environment would then feature as a higher priority on the department's budget.

The political framework within which energy planning and service provision takes place, has until now, taken a top-down approach to commissioning research, ignoring the input and participation of marginalised groupings such as the poor and, especially, women (the main end-users in the household sector in general and especially in the urban poor household sector). The lack of qualitative research and decision-making bears testimony to this. Qualitative research as a more intimate and thorough methodology, would undoubtedly include micro scale determinants which are likely to be overlooked in quantitative research.

IEP therefore needs to be adapted to include two important criteria when it is utilised as a research methodology. These criteria are integration and scale and are directly linked. Integration requires that energy planning be part of an overall development plan for a local area or region taking into account the way in which elements of the same system can be linked in the most cost-effective and efficient way. For example, the principle of integration would ensure that the provision of housing includes the simultaneous provision of ancillary services such as electricity, other utility services, roads and so on. Scale has a quantitative and qualitative nature to it. The quantitative reigns at the macro or national level and the qualitative, mainly at the micro or local area level. Policy formulation and funding commitments at the national scale are largely based on quantitative criteria or projections. While there is some application of this at the micro scale for practical purposes, the delivery of qualitative products can only happen at this scale, for example, improved thermal comfort.

Energy planning would be more effective if the two scales are utilised in an interdependent way. Existing information and data sources on energy efficiency in the urban poor household sector covers mainly the macro scale. Primary research on energy efficiency therefore needs to focus on the micro scale.

4.2.1 IEP and modelling

The literature reviewed in this paper clearly emphasises that one of the most important macro determinants of a household's energy consumption is its geographical location. The studies mentioned above are therefore neatly categorised into climatic zones. The seasonal nature of fuel usage for different end purposes among the urban poor is, however, ignored in some of the work completed on energy end-use patterns among the urban poor in South Africa.

The data analysed by Afrane-Okese (1995: 16) on space heating, for example, shows that coal is used by a relatively small percentage of households in the three climatic zones identified in his study. This is not consistent with the known situation that coal is widely used in the Gauteng province. One of the reasons for this is that some of the data might have come from summer surveys but was treated in an 'all-year' fashion.

The problem associated with the analysis of data in this way, however, lies in the fact that modelling, in this case the LEAP model, as a technical analytical tool of IEP requires the categorisation of data in a specific way in order for it to be utilised effectively to determine user demand. Chapter two describes how data needs to be arranged so that it can neatly fit into the LEAP model. One aspect of this arrangement is the manipulation of data into three broad climatic zones (temperate, hot-humid and hot-dry).

Again, this raises the question of scale in assessing the focus group of this study. While the model enables the literature to undertake demand analysis at a broad national scale and in this way, inform energy policy at this level, it does not advance the argument for improving energy efficiency at the micro or household scale.

It is reiterated here that the predominance of macro scale determinants informing the urban building process prevents urban place-making from responding to the natural conditions

prevailing in certain local areas. Macro scale determinants can only be stated broadly and therefore often fail to inform site specific conditions which informants at a micro scale are able to do and therefore contribute optimally to the thermal efficiency and comfort of the dwelling.

Seasonality needs to be considered in the provision and planning of energy services for the urban poor household sector in South Africa. In the planning and provision of energy services for the urban poor household sector, there is a need to adapt IEP in such a way so as to incorporate and bring together macro and micro elements or determinants into the process.

4.2.2 Determinants of DSM

The determinants of DSM were mentioned at the outset of this paper and are listed here again for ease of reference. They include the following (Eberhard 1994):

- macro economic data
- demographic data
- sector and subsector data for each end-use
- consumption sector and fuel
- fuel price
- cost of alternative fuels
- availability of fuels
- connection or access charges
- reliability of supply
- uniformity of quality
- convenience of use
- technical and economic characteristics of energy-using equipment and appliance
- availability of credit
- income
- rate of urbanisation
- social preferences
- acceptability
- knowledge of potential users

The literature on energy efficiency mirrors some of these criteria or determinants and DSM strategies employed by suppliers at the national level, are also well informed by them. The last three, however, i.e. social preferences, acceptability and knowledge of potential users, while in some instances documented (Thorne and Qangule 1994) are not widely used to inform analysis on energy end-use and consumption patterns among the urban poor household sector. In identifying the elements of a gender-sensitive planning approach, Makan (1994) recognises the need for a holistic approach which emphasises an in-depth understanding of energy end-users.

These three determinants have a qualitative touch and can be determined only at a smaller scale. For example, knowledge of users and acceptability of energy services or supply to the user, can only be thoroughly explored at a smaller local area or household scale. Hence, the importance of scale and qualitative research arises once more.

Williams (1994: 10) states that 'there are numerous determinants of energy demand some of which can be described as macro, that is, external to the household, while others act at the micro level, within the household itself.' These micro scale determinants are listed below.

- household size, including lodgers (concept of number eating from the same 'cooking pot')
- house structure, insulation, orientation, number of rooms
- tenurial rights
- water supply type
- household income, including patterns and reliability
- expenditure on all household requirements
- status (gender, age, education) of fuel and appliance user
- extraordinary energy use, feasts, funerals
- preferences, for example, dietary
- home-based productive activities
- health and safety considerations
- fuel prices, including alternatives
- availability and access to energy carriers
- reliability of supply and uniformity of quality
- cost of access to energy carrier, for example electricity connection fee
- appliances, source, cost, length of ownership
- technical and economic characteristics of appliance-fuel combination, convenience of use, multiple end-uses

From an energy efficiency and end-user perspective, the criteria listed above should include considerations which examine the urban poor household sector's energy needs in an all-inclusive way. This is significant in two ways. Firstly, research will be based on the needs of this sector and not on demand, which has an economic implication. Needs are defined as the energy requirements expressed by the target group itself. This is distinguished from demand which is inferred from data collected from a survey where the representativity of the sample is determined outside the user community and from a research perspective. Secondly, energy considerations will not only focus on the household itself but on other energy-related aspects as well. For example, end-users, especially in the low-income bracket, would take account not only of the end-uses focused upon in the literature i.e. cooking, space heating, water heating, lighting, refrigeration and media but would consider transportation as well.

In fact, transportation is an important aspect of any end-user's energy-related considerations and constitutes the means by which urban areas are connected to one another. It would constitute a very important energy consideration for any economically active householder in the focus group of this study if his/her livelihood depends on traveling/commuting between home and a place of work. It is important to note that the financial benefits of employment enable households to acquire access to other energy carriers necessary to run the household.

The structure and form of the South African city is not very conducive to efficient traveling and commuting (Boerne and Hatfield 1994), especially for the urban poor household sector who most often reside on the urban periphery and away from higher order urban opportunities like places of work, hospitals, tertiary educational institutions and so on. City structure is oriented to accommodate mainly road transportation and especially the private motor-car which in itself presents problems such as those of congestion and pollution. The private motor vehicle is not a

very affordable commodity given its high entry-and-operating costs. Household energy needs and demand should therefore take into account transportation requirements.

An unresolved question related to energy efficiency which was mentioned earlier is that concerned with the strategies households themselves employ to conserve energy sources. This has a direct bearing on the extent to which households themselves are involved in energy research, policy and decision-making. Again, qualitative research would include participatory planning methodologies which include the household itself.

The list of determinants should therefore not be seen as conclusive and should be extended to include, among others, scale, transportation energy, participation and qualitative criteria.

4.2.3 Supplier-informed DSM

Current demand side management programmes are mostly suited to the needs of the supplier rather than the needs of the target group of this paper. Hence, it is referred to as a supplier-informed demand-side management tool.

Demand-side management programmes employed by utilities and distributors tend to focus on direct load control to reduce peak load. Eskom's focus, for example, is mainly on the utilisation of its surplus capacity and sustaining the decrease in the real price of electricity. Its RDSM programmes are focused on reducing peak demand especially in the domestic sector. Local authorities engage in demand side management practices for much the same reasons, that is, to reduce the demand on the electricity load at peak time. Improving thermal performance as a DSM tool, is an important and cheap option which can be incorporated into the country's housing and electrification programmes and from which benefits can be derived for suppliers and end-users alike, especially end-users in the urban poor household sector. While there are merits in the application of other tools such as solar water heating and appliance labeling, the question of this sector's ability to gain easy and affordable access to appliances, needs to be addressed and overcome.

Other than serving the direct interests of suppliers or distributors, energy efficiency measures employed by them are seldom based on end-users' energy needs. Hence, DSM is essentially a supplier-informed management tool. Suppliers of electricity are informed by electricity demand, not end-users' energy needs and multiple fuel considerations. Hence, their focus on technological and economic solutions to energy efficiency in the household sector.

So, what benefits are to be gained by the urban poor household as end-user other than active attempts on the part of distributors of electricity to improve the thermal performance of low-income urban households through retrofitting or supporting the thermal comfort of new housing developments? Many low-income urban households do not have access to electricity at all. If *efficiency* refers to the optimal usage derived from the supply of energy sources at the least financial cost to the user community and the supplier and *energy efficiency* incorporates the principles of sustainability, equity and efficiency defined earlier in this paper, then the application of supplier-informed energy efficiency interventions have not been very successful in the urban poor household sector.

Anderssen and van der Merwe (1989: 96) identify the possible factors which inhibit municipal distributors' application of effective DSM programmes. These include, among others, a 'top-down' regulatory climate. What is meant by this is that existing regulatory and governance measures on electricity distribution in South Africa, are very controlled and therefore limiting in terms of permitting local authorities to be creative about demand-side management practices. As stated in chapter three, energy efficiency is not catered for in the regulations governing electricity distribution, namely the Electricity and Eskom Acts.

The other important inhibiting factor mentioned by Anderssen and van der Merwe (1989: 97) is the fragmented nature of the South African electricity distribution system which is not conducive to DSM. The country has a large number of local authorities. The effort to persuade so many

municipalities to adopt DSM as a management tool is quite an onerous task, especially if returns on their 'investment' cannot be guaranteed and/or measured in monetary terms. Incentives are therefore required to convince municipalities and smaller distributors about the merits of appropriate DSM programmes.

Again the question of demand analysis versus households' expressed energy needs is exposed. The economic culture of suppliers is to ensure a return on their 'investment'. Returns on DSM 'investments' cannot always be quantified and are at times more beneficial to the end-user than the supplier, for example, the promotion of multiple fuel usage. Investment in end-use efficiency infrastructure by local authorities, such as the provision and promotion of natural or coal gas piping to households, is not seen as a priority against electricity distributors' supply-side investments.

It is the business of local authorities to recover revenue, hence the emphasis on the sale of electricity! This practice needs to be re-evaluated against the principle of equitable and affordable access to energy services by the end-user, especially the urban poor household sector. Institutional and supply-side management arrangements need to develop their practices and re-prioritise their funding in accordance with the government's proposed electrification programme and other demand-side or needs-based informants. There are many benefits to be gained from certain DSM interventions by end-users and suppliers alike. Thermal efficiency is one such example.

The energy policy discussion process which culminates in an energy summit to be held on 20 and 21 November 1995 where relevant issues are to be placed on the national energy policy agenda, should be regarded as an important medium through which the promotion of energy efficiency practices in the urban poor household sector can be effected in such a way that it will filter through to the micro-scale context. It is through these kinds of processes that appropriate DSM strategies can be lobbied for so that they can be implemented at the micro scale. Processes such as these together with government policy-making can also be effective in influencing indirect supplier stakeholders like those of builders and mortgage lenders.

Also, in the past, funding commitments from national and local government were the main sources of dictating the structure and form of a single dwelling aimed at housing the urban poor. A single amount (say R40 000) would be made available for the construction of one dwelling. The focus therefore was on constructing a finished product worth R40 000. Other considerations like building materials and orientation which contribute to thermal comfort, were not taken into account. Attempts should be made to turn this process around by allowing the planning process to dictate the funding commitment to the construction of the dwelling unit so that it can be done properly first time round. Thorne (1995 : 50) recognises that 'mortgage lenders enter into 20 to 30 year relationships with borrowers during which borrowers are required to pay back loans. If the borrower is using less of his or her resources on keeping the house warm, this may imply that the borrower is able to afford larger loans in the first place and is in a better position to honour repayment obligations'. The relationship and potential for partnerships between policy-makers and informants of the policy-making process, should be explored more in the future.

4.3. Energy efficiency and fuels other than electricity

The literature reviewed on energy efficiency reveals that suppliers of LPG, coal and paraffin have no real interest in promoting energy efficiency in the urban poor household sector. The question arises, however, whether the onus should be on suppliers to do this or should it be on government as protector of the marginalised, promoter of energy efficiency and advocate of equitable access to energy services. The most powerful tool available to government is that of regulation. Regulations governing the processing and distribution of such fuels should therefore be examined and amended to take account of energy efficiency, health and safety measures. Some research has been initiated by the DMEA into low-smoke fuels as a solution to household air pollution problems (Dickson et al 1995).

In chapter three of this paper, it was suggested that the government's proposed housing and electrification programmes be used as an opportunity to provide new local areas with the infrastructure to accommodate a mix of fuels in order to increase household's choices and access to affordable fuels. National urban planning legislation and building regulations can facilitate this process along with promoting a mixed land use and integrated approach to mass housing development.

4.4. Energy efficiency and technology

Analyses of the potential for energy conservation typically begin with estimates of technical opportunity. The first step is to assess energy savings which might be achieved by the adoption of economically worthwhile measures and technologies ... The trouble is that the practical application of energy efficient technologies seems to be impeded by what are routinely referred to as "non technical barriers". The conventional view is thus one in which social obstacles inhibit the realisation of proven technical potential (Shove 1995).

These words can easily be applied to the DSM tools employed by suppliers to achieve energy efficiency in the household sector. Water heating load management strategies and appliance labeling, for example, include technologies which are either absent, inaccessible or completely foreign to low-income urban households. Hence, the social obstacles of affordability to acquire these and lack of knowledge or understanding of these technologies on the part of this sector 'inhibit the realisation of proven technical potential' (Shove 1995). A further inhibiting factor is that of the usage of energy sources other than electricity which cannot fuel these technologies and therefore cannot satisfy certain end-uses with a guaranteed energy saving.

The 'social obstacle' of affordability is related to the high unemployment rate or low-earning capacity of the target group of this paper. Access to electricity is inhibited by the entry cost of preparing the household for electrification. There are two important aspects to consider here i.e. to what degree can electrification contribute to job creation and how can electricity tariffs be established within a framework of integrated energy planning?

Shove (1995) recommends a socio-technical approach as opposed to the conventional 'techno-economic' approach to energy efficiency. By this, the author implies that social criteria complement and inform technological requirements for energy efficiency. While the literature reviewed in this paper takes account of social factors, these are hardly reflected in the strategies employed to effect energy savings in the low-income household sector. More appropriate energy efficiency measures therefore need to be considered. The end-users themselves can play a significant role in identifying these measures, hence the need for participatory research at the micro scale to determine appropriate energy actions to meet the energy needs of this sector.

Education of the supplier and end-users alike (a mutual energy learning process) is required to close the gap between the conventional 'techno-economic' and the 'socio-technical' approaches. There is a place for both as long as they are complementary and not mutually exclusive.

Conclusion and recommendations

5.1. Introduction

This paper has reviewed the literature on energy efficiency in the urban poor household sector of South Africa from an end-user perspective. It attempted to show what information and research is available on this topic and in what format it is presented. It also attempted to show the responses of suppliers to energy efficiency goals in the planning and provision of energy services to this sector. These responses were measured against the literature on energy demand among the urban poor household sector.

The general conclusions that can be drawn from this paper's analysis are set out hereunder.

5.2. IEP and DSM

The informants of integrated energy planning (IEP) and demand-side management as a component thereof need to be adapted and revised as a tool for energy project planning. IEP is a sound and useful method for informing national policy planning but is an insufficient tool for energy project planning at the household or micro scale. Furthermore, it should have as its foundation, the qualitative principles of equity, sustainability and efficiency and should attempt to incorporate all the different sectors (socio-economic, environmental, spatial and political).

Future research on end-use patterns among poor urban households therefore should attempt to develop a check list of determinants or elements at the micro scale which might influence this sector's decision making. This information, in turn, should be utilised to inform a DSMP.

Socio-economic indicators or variables (affordability, income, poverty, gender and unemployment) need to be included in DSM strategies. This is currently not the case. Also, performance standards which take account of qualitative criteria need to be formulated. The implication here is that if the intention is to build and /or electrify a certain number of dwellings per annum (quantity), there should be a simultaneous commitment to ensure that these dwellings are well insulated and therefore thermally efficient (quality of product). So the idea is to use the mass housing and electrification programmes as an opportunity to improve the living conditions of the urban poor.

The restructuring of local government provides an opportunity for integrated micro scale planning to take place. The delimitation of metropolitan areas in South Africa into larger and more manageable local sub-structures define spatial entities which can facilitate this process.

There are three important considerations here:

- the adaptation of the determinants of IEP and DSM as a component thereof so as to inform a methodology for micro scale energy planning;
- the formulation of performance standards for energy planning in South Africa; and
- addressing the question of whether current DSM policies are firstly, appropriate for the focus group of this paper and, secondly, whether they include socio-economic variables in their application.

It is therefore recommended that research be undertaken to revise and adapt the determinants upon which IEP and DSM as a component thereof, are based so as to create a methodology for micro scale energy project planning which should incorporate qualitative as well as quantitative

analyses. This research should involve a primary research component for which existing local area-based studies, like those completed by Thorne and Qangule (1994) on new electrification schemes in three areas in the Western Cape and Golding and Hoets (1992) on energy usage in urban black households in selected formal and informal townships, could form the basis.

It is further recommended that the appropriate application of existing DSM policies to low-income urban households be investigated and the inclusion of socio-economic variables be ensured in future strategies.

5.3. Energy efficiency and electrification

The work completed by Afrane-Okese (1995) mentioned in chapter two of this paper clearly shows that the simultaneous introduction of energy efficiency measures and electrification will decrease the demand for electricity significantly.

For a large number of poor urban households, current inefficient end-use patterns are likely to continue even when they become electrified. The national electrification programme should therefore incorporate measures to address this issue. There also appears to be an assumption that this sector has access to appliances to utilise electricity for end-uses such as cooking. This is not necessarily the case and where appliances are accessible, electricity is not the most efficient energy carrier for cooking.

Most importantly, electrification in urban households should be considered alongside and in conjunction with the provision of other utility services (waste management, water supply, roads etc.) so that an integrated approach to the provision of services can be promoted. This requires the formulation of a prioritised area-based infrastructural investment programme incorporating all services for low-income households. One of the key elements of this programme is to determine how, from a financial point of view, such investment would be funded and how the issue of affordability is to be addressed.

Thorne (1995: 96) is cited here again as describing DSM in the context of energy planning as the 'management of electricity usage in order to reduce the life-cycle costs of supply.' It also includes the notion that the most efficient fuels should be encouraged to be used for different end-uses. The restating of Thorne's definition is to motivate for the national electrification programme not to be seen in isolation from the usage of other fuels by low-income urban households. These households use a number of fuels simultaneously (Basson 1994). It is therefore important to provide them with a choice of fuels.

The two important aspects to be considered in the planning of a national housing and electrification programme for the urban poor are therefore:

- the consideration of electricity along with other utility services for the target group of this paper; and
- encouraging this sector to use the most efficient fuels for different end-uses by providing safe and convenient access to fuels other than electricity.

It is recommended that the preparation and/or planning for the implementation of the national electrification programme be complemented by research work on the provision of other services as well. It is further recommended that research be conducted on the provision of safe and convenient access to fuels other than electricity so as to widen its choice and encourage the efficient use of energy sources.

5.4. Energy efficiency and transportation

Research determinants should include the varied considerations which reflect more accurately the energy needs of the urban poor household sector. These needs are not only about household

fuels. They include energy for transportation to travel between origin (the household) and destination (mainly the work place).

In chapter four provided motivations for why household energy needs and demand should take into account transportation requirements as well. It was also argued that research on energy efficiency from an end-user perspective, needs to be conducted in a coordinated and integrated way i.e. housing, electrification, transportation etc. should be regarded as elements of the same system. The government's proposed mass housing and electrification programmes provide an opportunity to include other energy-related sectors such as transportation.

The transportation sector is also a large consumer of energy which poses other environmentally-related problems to the country. There are therefore two aspects of this sector which need to be investigated. The two are by no means separate but are concerns at different scales. Firstly, at the micro scale, the issue of access to energy efficient transportation by low-income urban households needs to be investigated. Secondly, at the macro scale, an environmental impact assessment of the transportation sector needs to be undertaken with a view to making this sector more energy efficient.

It is recommended that access to energy efficient transportation by low-income urban households and energy efficiency in the transportation sector, be investigated.

5.5. Thermal performance and integrated design

Improving the thermal performance of housing structures is not necessarily a priority among suppliers like Eskom and local authorities. National building regulations and urban planning legislation do not compel suppliers of housing products to attend to thermal comfort.

While information on passive thermal design is abundant, it has not been utilised very well in the design and implementation of low-income urban housing developments. This literature is also limited because of its focus on the dwelling only. Broader locational aspects such as the soil conditions of land, which can make a significant contribution to thermal comfort should also be considered in thermal design.

Energy end-use demand and consumption patterns are considered at a scale which is suitable for the formulation of national energy policy. Climatic zones, for example, are divided into six or three broad zones for this purpose. However, micro-climatic conditions need to be studied very carefully in order for optimal passive thermal design to take place. Natural elements (sun, wind, vegetation and so on) which should inform design at this scale, differ from local area to local area.

Future studies on the improvement of thermal performance and energy efficiency in the provision of low cost housing therefore need to focus on the following:

- the development of pilot projects where energy efficiency measures can be introduced;
- facilitative policies and legislation to entrench thermal design in the provision of housing;
- new housing developments should be targeted as models where thermal design can be introduced, monitored and evaluated;
- broader (than the dwelling's structure) planning issues like the siting of local urban areas on land which is generally suitable for urban development. These and other concerns mentioned in chapter three of this paper must be considered at the very outset of the planning process; and
- the sensitivities of low-cost housing design to the natural elements prevailing in local areas.

5.6. Appliances

This paper has not focused much on appliance efficiency because it is being investigated as a separate research paper within the Energy and Environment Programme. It is, however, necessary to reiterate that the continuation of research in this field especially on appropriate labeling, standards, retooling and financing etc., is important and should therefore be supported.

5.7. Energy efficiency funding

From chapter three it is clear that Eskom and the DMEA appear to be the only agencies in South Africa which have made some funding available for energy efficiency programmes in the low-income urban household sector. Suppliers' should be encouraged to reprioritise their budgets so that funding for research as well as energy efficiency projects for implementation in this sector become a higher priority.

It is recommended that funding be prioritised so that effective energy efficiency programmes can be considered for implementation and research into appropriate energy efficiency / DSM interventions be conducted. In addition, the idea of imposing a levy on commercial energy fuels to fund energy efficiency programmes and the establishment of an energy efficiency agency should also be investigated.

5.8. Education

Energy efficiency education is a two way process. Suppliers' need to understand the energy needs of low-income households from an end-use perspective as much as end-users need to learn about the various options available to them to conserve energy. The areas where education can play an important and immediate role include the following.

On the end-users' side:

- the meaning of energy efficiency;
- the improvement of thermal performance in self-made and/or other low-income housing;
- the safe, convenient and efficient use of energy carriers, including electricity; and
- the standards and life-cycle costs associated with dwelling structures and appliances.

On the suppliers' side:

- the true meaning of energy efficiency from an end-user perspective;
- the role of effective and appropriate DSM practices/interventions in the low-income household sector; and
- the need for socio-economic indicators or variables to be included in the planning and formulation of energy policy including the participation of marginalised groupings.

5.9. Energy efficiency in southern Africa

It is important for South Africa to understand and learn from its regional counterparts especially while the climate is right for regional cooperation in the energy sector. Zimbabwe, Tanzania and Zambia have the most active energy efficiency programmes in the region and either already have or are close to developing a national energy efficiency strategy (Stiles 1995).

Zimbabwe is in the process of developing a national energy efficiency improvement programme. Tanzania already has a national energy policy which includes energy efficiency. Its implementation is, however, stifled by a lack of finance from government. Zambia's Department of Energy has an energy efficiency policy in place which requires that stakeholders, mainly

industry, provide government with information on the best ways of improving energy efficiency in the country.

It is recommended that a literature review be undertaken on energy efficiency and DSM interventions in the urban household sectors of these three countries in southern Africa.

5.10. Coordination and integration of services

For the provision and planning of energy services to be effective in the low-income urban household sector, it is necessary that direct or indirect suppliers and providers of such services, work in a coordinated fashion. At the same time, coordination can facilitate an integrated approach to the planning and development of other utility services such as street lighting in conjunction with energy services.

Furthermore, there is also a necessity for partnerships to be formed among suppliers, researchers in the energy sector and end-users. While the complexity of such an arrangement is acknowledged given the conflict of varied interests, the current paradigm of restructuring, transparency and legitimacy in South Africa provides an opportunity for this to happen.

It is recommended that this aspect of energy efficiency be expanded towards achieving coordination among various stakeholders. It is further recommended that the application of DSM by municipalities, also be expanded with a view to formulating a coordinated DSM programme for the anticipated restructured local authorities in conjunction with Eskom as the major distributor of electricity.

5.11. Conclusion

The information available on energy end-use patterns which is utilised to inform energy demand often reflects energy supplied to end-users as opposed to actual energy consumption. Surveys informed by end-user data such as the studies completed by Afrane-Okese (1995) and Trollip (1994), frequently omit qualitative factors about usage patterns. This has the effect of obscuring important factors regarding why and how consumption of energy sources takes place and may significantly distort demand analysis of the urban poor household sector. For energy efficiency measures to be successfully introduced and applied in the urban poor household sector, an in-depth understanding of the energy needs of this sector is required. It is therefore proposed that energy planning for the urban poor household sector begins to focus on the micro scale where a thorough understanding of the energy needs of this sector can be obtained.

The energy efficiency and demand-side management practices employed by distributors of electricity are appropriate for the management of their loads. However, these practices are not necessarily appropriate for the urban poor household user community. The reasons for this are: firstly, a large proportion of this sector do not have access to electricity and where electricity is available, there is still a reliance on other fuels like paraffin and secondly, this sector's energy end-use consumption patterns are largely influenced by socio-economic factors (for example, affordability) which make such patterns very different from the conventional electricity-based usage patterns of other urban households.

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