APPENDIX F: REVIEW OF COMPLETED PROJECTS

R Triebel in the *Feasibility study on energy efficiency communication programmes aimed at the industrial and commercial sectors*, 1996, highlights several points surrounding energy efficiency. Programmes and policies that are most commonly used to encourage energy efficiency in industry and commerce can be divided into the following general categories,

- Information and technical assistance; these are aimed at encouraging energy efficiency. They would typically involve energy audits and information dissemination. It could also include identifying best practice benchmarks.
- Technology development and commercialization; This covers the promotion of energy efficient end-use equipment. Also any research into the efficiency of equipment. Development could be in the area of sector-specific processes or technologies for producing steam, compressed air, motors etc.
- Corporate commitment and recognition; this involves the recognition by government of companies that have adopted energy efficiency.
- Industrial DSM promotion and assistance
- Tax and fiscal measures; these include environmentally orientated energy taxation and fiscal incentives aimed at encouraging energy efficiency.
- Standards and regulatory instruments; It is difficult to establish industry standards because of the different nature of energy use in industry. Standards can relate to performance requirements, or conduct requirements such as performing energy audits.

Government involvement in energy efficiency programmes should take place in three phases, these can be briefly summarized as the preparatory phase, penetration phase and reinforcement phase.

During the preparatory phase, a profile for energy efficiency is developed. Most developing countries fall within this phase. Economic growth occurs without concern for future resource constraints and there is an ignorance of energy and energy efficiency. Where there is a lack of awareness of the need and benefits of energy efficiency government needs to increase awareness. Campaigns to raise awareness through advertising in newspapers, magazines and television are generally effective, These campaigns should be aimed at the public, decision makers and technical staff. Although this is unlikely to increase energy efficiency, by raising awareness, the second phase of penetration is more likely to be successful.

The preparatory phase is aimed at those who, after developing an awareness of energy efficiency would participate in improving energy efficiency. The target group for this phase are decision makers and management. Success in this area has come from implementing a variety of programmes, not a single programme. Technologies are promoted through technical material and demonstrations, or national energy awards. This phase also includes

- training and education
- energy audits
- Technical assistance and
- Standards

For a programme to be successful, it needs the participation of utilities, public interest groups, trade unions, industry themselves and government.

The implementation of energy efficiency programmes in South Africa is described as being "fragmented and ad-hoc. No single institution or organisation has as yet been involved in the development and implementation of energy efficiency actions that can be termed effective on a national basis or long term in nature."

Experience in developed countries has shown that collaborative efforts in programme design involving the participation of various groups has led to actions being implemented that are more acceptable to the market place.
Major role players are identified as being

- Government; the role of government seen by industry is one of facilitation and coordination not implementation. Funding , tax concessions, reducing import tariffs and deligislation are suggested as ways to improve energy efficiency.
- Energy suppliers
- Equipment manufacturers and suppliers
- Consultants, auditors architects and other advisory and designing services
- Other players
    - Industry association/ interest groups
    - Energy related equipment suppliers
    - Energy consultants and auditors
    - Research institutions
    - Education institutions

Within industry energy efficiency is not often dealt with, and government support is limited. Barriers to improved energy efficiency are identified as:

- Low level of awareness,
- Priorities,
- Knowledge and information,
- Human resources,
- Risk,
- Lack of technology, equipment, and technological innovation.

The way the message of energy efficiency is brought across must appeal to the self-interest of the company or industry. The appeal can be rational, emotional or moral. Messages promoting positive consequences as apposed to prevention are more likely to succeed. Rational appeals likely to encourage industry and commerce are:

- MONEY,
- Competitiveness,
- Improved productivity,
- Product quality,
- Profits,
- Substantial savings,
- Sensitivity to current loss rather than future gain,
- Comfort,
- Managing decline,
- Survival,
- And to a lesser extent, reduction of polluting emissions.

Communication channels identified are personal and non-personal. Personal would be face to face, person to audience or telephonically. Personal communication includes discussion groups with various role players such as government departments, advisory services, manufacturers and equipment suppliers, energy suppliers and energy end-users and associations. Conferences reach a limited audience, but this can be overcome by using the media to cover key issues. The Media can be used to stimulate personal communication, raise awareness, and support approaches and highlight new technologies. Media includes newspapers, magazines and newsletter such as the "Paper South Africa" newsletter that is aimed at a specific target audience, radio or television.

Key thrusts for energy efficiency awareness creation in industry and commerce are identified as being,

- having a higher profile for energy efficiency,
- gathering and sharing information to educate consumers,
- creating widespread awareness,
- establishing grass roots understanding,
- establishing an energy directive or centralized database listing energy suppliers, equipment manufacturers, energy consultants, professional service providers, energy service companies, government departments/agencies, education institutions, market research companies, auxiliary service providers, etc.
- Facilitating an energy friendly economic environment, this must be done with a good understanding of industry needs and energy consumption profiles.

The study entitled *Information Dissemination programme for EU energy efficient technologies in South African Industry* conducted by ETSU in 1999 investigates the possibility of exporting energy efficient equipment to South Africa and highlights the following.

A Key finding was that energy efficiency is not developed enough in South Africa to simply promote hard technologies- awareness raising, capacity building, training and promoting information networks are required first.

The aim of the project was revised to collecting information on South Africa and to understanding the energy situation. The partners in the project were NOVEM and AEA Technology. The project covered identifying target sectors or technologies, understanding how local factors will affect the programme, and developing ideas for the programme.

Energy efficiency in South Africa has not been given much attention, the reasons for this are given as:

- The low cost of energy,
- A surplus of electric generating capacity,
- Energy efficiency has not been a government priority,
- High cost of capital,
- Large industry has made an effort to keep electricity prices low
- Plans to liberalize the electricity market have diverted attention from energy efficiency,
- the level of awareness, understanding, skills and knowledge surrounding energy efficiency is extremely low. There is little application of energy management, and low or no cost measures to improve energy efficiency.

- There are few drivers that encourage improved energy efficiency.
- Previously industry saved by cutting labour costs.

Industries to target with energy efficiency are;

- Mining, esp. gold
- Basic iron and steel
- Basic precious and non-ferrous metals
- Petroleum refineries and synthetic fuel plants.

Possible energy efficiency savings as a percentage of total energy used were identified in the following areas;

- textiles 35%,
- Cement 25%,
- Boilers 40%,
- Drying 35%,
- Compressed air 40%

Demonstration of the benefits of energy efficiency is crucial for success. Case studies from outside South Africa, covering the implementation of energy efficiency measures, have limited appeal to South African industries due to different conditions. Industry feels that it is unique in its processes and needs.

The SADC Industrial Energy Management project (SIEMP) is involved in energy management training in SA and carrying out case studies in the region. The Canadian International development agency funds training provided by the SIEMP. The programme currently has no plans to include South Africa but opportunities will be sought to extend the coverage to SA. SIEMP will provide training for host sites.

Packaged information is required in the form of

- guides, these will cover technology issues surrounding that latest energy efficient technologies such as the latest motors, etc.
- Introductory booklet, on energy management systems,
- A list of names and contact details of experts and organizations active in this field in the EU and South Africa. Contacts details for the manufacturers of energy efficient technologies and their representatives in SA,

Awareness building is targeted at high level management, technical staff and consultants,

- Senior management must be made aware of the financial benefits of energy efficiency. It must be demonstrated that energy efficiency can be incorporated without excessive effort and with impressive results.
- The technical message is results based, with facts and info about energy savings costs of technologies and payback periods. It could cover conducting simple energy audits. It is aimed at raising the level of skill.
- Educational institutions professional engineering associations, and companies that manufacture, market and install energy efficient products and services.
- Government

Review of objectives and results

- Barriers: energy costs low; investment costs high; government priorities are elsewhere; politically the focus is on keeping electricity prices low throughout the deliberations.
- A foundation for energy e must be created; SA needs technical assistance and capacity building from EU.

Identifying target sectors can be done by collecting European statistics, for comparison with South African, in terms of

- energy production by fuel type,
- production of electricity by fuel type,
- current energy production and consumption of renewables,
- potential energy production and consumption for renewables,
- energy consumption by sector,
- comparing energy intensity in South Africa to international norms,
- developing a graph of energy consumption over the past 4/5 years.
- Quantifying energy consumption by industrial sub- sectors and energy intensity by sub-sectors.

The motivators for energy efficiency are;

- Energy cost ,
- Realization of saving potential,
- Awareness through career training,
- Management priorities,
- Appreciation that saving can be made through correct equipment operation,
- Sufficient information.

Further barriers to energy efficiency;

- Outsourcing trend- focus on energy efficiency becomes indirect,
- Political changes-no clear national strategy,
- Structural changes- energy efficiency concepts cannot be well installed on a moving platform,
- Lack of guidance – for energy consumption in the marketplace,
- Lack of finance- difficult to obtain finance at realistic interest rates.

The relevant organizations to involve in energy efficiency are covered in detail and identified as being,

Government:

- Department of Minerals and Energy
- Department of Trade and Industry
- Department of Environmental affairs and Tourism

Government policy and initiatives include the following

- Draft white paper on energy policy, the key objectives being
    - Increasing access to affordable energy services,
    - Improving energy governance,

  - Stimulating economic development,
  - Managing energy related environmental impacts and
  - Securing supply through diversity.
- Restructuring of the energy sector,
- Emissions regulations,
- Incentives and support measures,
- Manufacturing standards.

Energy suppliers
- ESKOM

The restructuring of the electricity distribution sector is a government priority, but agreement cannot be reached on how to achieve this.

Others
- Industrial Development Corporation
- South African National Energy Association
- Southern African Development Community

The review of energy efficiency dissemination activities covers efforts by several players currently involved in the energy efficiency field these are the,
  - Energy Research Institute,
  - The Department of Minerals and Energy,
  - Energy Efficient Design Award,
  - Energy management courses, University of Witwatersrand,
  - CNES and USER, University of Pretoria,
  - National conferences, Enerconomy ’92 and ’93,
  - Energy efficient workshops as part of the national energy policy summit,
  - Regional energy forum of the WEC.

Activities in which donors have been involved include;

  - US SA energy summit
  - Netherlands energy efficiency study tour
  - EU sustainable energy conference June 1997
  - JETRO Energy efficiency seminar March 1998

The study develops a detailed plan for energy efficiency and an energy efficiency dissemination programme. These are to be completed in two phases. An initial phase of planning and a final phase of implementation. The EU has committed itself to assisting South Africa in implementing actions that twill lead to the overall improvement of energy efficiency in industry and mining.

Information dissemination is aimed primarily at high level management in industry, technical staff in industry and technical consultants. It is also aimed at government, educational institutions, professional engineering associations, energy suppliers and engineering companies.

The information dissemination programme will cover the following elements
  - Case studies,
  - Training ,

- Packaged information,
- Awareness building and
- The formation of databases

Professional associations, research organizations, universities and technicians, industrial associations, sectoral industry organizations, energy suppliers, technical journals, financial management journals and commercial organizations to include in future energy efficiency drives and information dissemination are listed.

The *Potential for conservation of energy in South Africa*, A.T. Williams, 1986, covers the potential for energy conservation in the various sectors of the South African economy. It outlines the efforts of several countries to improve energy efficiency through the introduction of programmes. There is a close correlation between the success of these and the clear focus of government. In countries such as Denmark, France and Germany where governments have placed a high priority in establishing programmes for determining what conservation measures to implement, there has been great success.

The report focuses on the sectors of South Africa that are the largest consumers of energy, these being; the gold mining industry, the iron and steel industry, the cement industry, the chemical industry , the brick industry and the paper industry, it also focuses on energy conservation in large buildings.

Experience in developed countries allows energy to be focussed in areas that will bring the greatest reward, these are;

- Promotion of detailed energy audits of energy intensive industries, where energy accounts for 15-50% of production cost,
- Develop strategies for smaller industries less sensitive to the importance of energy efficiency. These could be special surveys, audit programmes, incentives and the development of finance institutions,
- Enhanced supply of energy conservation equipment such as waste heat boilers, heat exchangers, instrumentation and insulation. This can be achieved through promoting import policies, investment incentives and licensing joint ventures,
- Developing a local capacity for energy audits.

Changes in energy consumption of industry can result from

- A change in the total output of the industry,
- Changes in the product mix,
- Changes in the energy intensity of production.

It appears that there is an advantage in having an agency independent to government to assist with policy formulation. This lies in the potential for vigorous promotion of energy conservation and not that of caution normally followed by government.

Australia established a national energy conservation programme in 1979. Initial focus was on awareness and education. In 1980 a national energy management scheme was introduced to establish commitment to better energy management. The main elements of this are, energy management seminars and workshops, subsidising up to 50% of the cost of energy audits and national energy management awards. There is a national energy research development and demonstration programme.

In Austria a semi-autonomous high profile organisation was established. The energy efficiency agency established in 1977, is funded by central government. The programmes have focussed on raising awareness and have been successful. In 1979 an energy conservation programme involving tax incentives and grants was initiated in the domestic sector.

In France energy conservation is in the hands of a single semi-autonomous body launched in 1982. The agency is under the control of the Ministry of Industry and Technology. It has a research and development and demonstration programme. The incentives are

- Tax deductions for investment in energy saving processes and equipment,
- Medium and long term loans at preferential rates,
- Accelerated depreciation of energy saving investments,
- Support for investment in return for setting agreed energy targets.

Japan's energy conservation programme is run by the Ministry of Internal Trade and Industry. In 1997 the Law for Rationalization of Energy Consumption was enacted. Incentives for improved energy efficiency include;

- Loans from the Japan Development Bank and Medium and Small Enterprise finance corporation,
- Tax measures in terms of accelerated depreciation.

The Moonlight project started in 1978 is a national project for the promotion of research and development into energy conservation technology.

The United Kingdom has a fragmented policy that has met with little success. The Energy Conservation Demonstration Projects Scheme is sponsored by the Department of Energy and Industry.

The United States has a number of assistance programmes for sectors of the economy, these include; advisory services on new technologies, waste heat recovery and reduction, fuel economy standards for vehicles and voluntary building guidelines amongst others. State governments are also responsible for a variety of programmes.

West Germany has a Federal Ministry of Research and Technology. Grants and tax incentives are used to encourage energy management.

Gold mining consumes half the energy in mining, this is mainly in the form of electricity and is used for environment control, rock breaking, lifting and hauling. Areas where energy efficiency can be improved in the gold mining industry are improvements in the energy efficiency of air conditioning, heat exchangers, energy recovery from water systems, performance of refrigeration plants, the use of ice for cooling mines and rockdrilling.

The Iron and steel industry compares favourably on an energy use base with other countries when the poor quality of coking coal is considered. Coal is the major supplier of energy in this industry and forms 90% of total consumption. The steel industry accounts for about 10 percent of total demand. Depending on the country and process adopted, there is a large range in the SEC of steel producing countries. Japan has a high energy efficiency that can be attributed to the use of modern technology, Italy's energy efficiency is attributed largely to the scrap fed electric arc furnaces. China has a

high SEC caused by the small quantity of scrap used, the poor quality of ore and coking coal and the use of small energy intensive open hearth blast furnaces. Energy use is substantially higher when alternative fuels are used as replacements for coking coal. Direct reduction is energy intensive but popular because it allows iron ore can be reduced by low grade coal or gas reducers to sponge iron, which can then be charged in an electric furnace and converted into steel. Good housekeeping can provide savings of up to 3-4% of the total energy used in steelmaking. Housekeeping measures are defined as low or no cost measures that can be implemented with a less than 1 year payback. Possible areas for improving energy efficiency are waste heat recovery, improved insulation and flaring of self-generating fuels. The collection of BOF gas can also result in substantial savings.

Cement production is also energy intensive. Energy intensity in the cement industry is a function of the process used, the age of kilns, the raw materials, kiln capacity and steadiness of operation. The most important factor is the process. The wet process is approximately 40% more intensive than the dry process. Larger kilns have greater energy efficiency. There is no clear trend between the choice of fuel and energy efficiency. Opportunities for Improvement in energy efficiency lie in waste heat recovery, suspension preheating, particle size control and reducing the amount of water in the raw meal. Areas requiring attention are the preheating of raw meal, radiation and convection losses. Energy trends in the cement industry have been towards lower fuel consumption and higher electrical energy consumption. It is expected that without breakthroughs in technology, the SEC of cement production will level off at between 3.5 to 4.00GJ/ton.

The chemical industry is an important area to concentrate on because of the dual nature of the raw materials as feedstock and fuel. Design emphasis in the process has been on limiting capital costs, paying little attention to energy costs. It has four production components that cause the high energy intensity of chemicals production; separation technology, chemical conversion, utilization of low temperature heat and reduction of inert materials. 5-10% of total energy in the US chemical industry has been saved through good house keeping measures. Technological savings will amount to between 2 and 24%. Other potential savings result from waste heat recovery, utilization of gas to gas and shell to tube heat exchangers for the recovery of heat in the flu gases, preheating combustion air and better insulation of furnaces and improved furnace efficiency.

Glass industry produces both flat glass and glass containers. The glass industry has an average SEC of 18GJ/ton of solid glass, glass containers have an SEC of 15GJ/ton. Melting furnaces are the largest users of energy requiring between 70 and 87 percent of the fuel. Important areas for energy efficiency in this industry are good housekeeping, thermal insulation, furnace design, efficient heat transfer flow patterns and temperature profiles within the furnace. Continuous glass tanks are fitted with heat regenerators. These can recover about 40% of the input energy. The recovered heat is used to heat air going into the furnace. Production planning and operating under steady conditions also has a positive effect on energy intensity. The use of tons of glass as a measure for SEC requirements has the shortcoming that decreasing the mass of a container of a particular size increases the SEC required.

In the brick industry it is estimated that up to 5% of energy could be saved through good house keeping. This includes sealing leaks on kilns, repairing doors on dryers and

providing lagging on ducting. Small capital expenditure on insulation of dryers and improved instrumentation and metering could yield potential saving s of up to 10%.

Data for the SEC of different kiln types are given as

Kiln type	Ave GJ/ton	Range GJ/t
Tunnel	3.51	2.08-5.72
TVA	2.94	1.48-4.02
Downdraught	8.49	6.13-11.34
Hoffman	1.97	1.25-3.72
Clamp	3.66	2.03-5.82

Firing temperature and brick quality affect the energy intensity of kilns. Tunnel kilns are used to make higher quality bricks and therefore have a longer firing time and higher firing temperature. Areas requiring attention are improved control of firing, use of waste heat recovery, loss of heat supplied to kilns through the use of kiln cars and less volume of material for a given output of brick. Wood fired clamp kilns would benefit from technological advances. From an energy perspective it is better to build with concrete.

The energy intensity of the pulp and paper industry, lies between 40 and 60 GJ/ton. Installing heat recuperation retrofits can result in large energy savings. Cogeneration opportunities also exist. House keeping and the efficient management of coal fired boilers will result in the largest savings. A thermal efficiency of around 80% should be aimed for.

Energy conservation campaigns should be conducted in the following stages

- Create awareness of the need to save energy,
- Increase awareness in the ways of saving energy,
- Demonstrate how energy can be saved.

Campaigns to create awareness should encourage discussion and debate, not just provide information.

In the *Development of a draft manufacturing and mining energy effectiveness strategy for South Africa.* M.G. De Villiers, R.K. Dutkiewicz, 1994. The need for an industrial energy effectiveness strategy is highlighted by the high industrial energy intensity of mining and industry per output of GDP (double that of most developed countries). 11% of GDP is spent on energy compared to the 5-9% of most other developed countries and the energy is inexpensive. The cost of energy to industry rose 63% between 1970 and 1985. There is the potential to save R1152 million (1993) through increasing energy efficiency.

Benefits in improving energy efficiency are,

- Greater international competitiveness,
- Reduced local consumer cost,
- Reduced energy expenditure which frees finance for investment,
- Less environmental impact,
- Decreased unemployment.

Parties to include are (government to decide the role of each),

- Energy suppliers, they are familiar with technologies, the needs of the customer, and consumption patterns. The advantage to the supplier in promoting improved energy efficiency is that their energy becomes more attractive. The disadvantage is the reduction of use and the need for additional manpower. Eskom is in an ideal position to promote energy efficiency however they centre on electricity and the government needs to stimulate the promotion of energy effectiveness by oil and coal suppliers. A workshop should be held with suppliers to establish the role of suppliers in promoting energy effectiveness and the benefits to them.
- Equipment manufacturers, recognise the need but are confused as to how to implement it. This needs to be discussed with them.
- Educational organisations,
- Energy contractors and ESCOS, these have the financial and engineering expertise to; perform audits, propose action, establish baseline consumption. Government needs to promote their establishment.
- ESCO's, barriers to their effectiveness are the complexity of contracts and an inadequate framework to support them, a lack of knowledge about their role on the side of potential customers and the initial high capital needed. South Africa may not be ready for these, the government could help to promote their work through tax incentives and finance incentives.
- Consulting engineers,
- Consumers,
- A government agency is needed to standardise procedures and pool information. The agency should be semi-autonomous. Tasks would be to monitor trends in energy efficiency, promote and assist with demonstration projects, disseminate information, undertake quick audits, provide training and assist regulatory authorities in the drafting of standards. International agencies that could be approached to provide assistance with training are,
    - The United States Agency for International Development (USAID)
    - International Institute for Energy Conservation (IIEC)
    - World Energy Efficiency Association (WEEA)
    - Energy Sector Energy Management Program (ESMAP)
    - Energy Technology Support Unit (ETSU)
    - Canada's Department of Energy, Mines and Resources (EMR)
    - Canadian International Development Agency (CIDA)
    - Demand side management Institute (United States)
    - The association of Demand Side Management Professionals (United States)
    - The Association of Energy Engineers (United States)

Government is responsible for policy around energy supply and demand. An essential prerequisite is a strong central energy effectiveness group. The function of this group would be to:

- Advise on policy,
- Set goals,
- Co-ordinate with other bodies and departments,
- Fund allocations.
- Evaluate programmes

Pricing policy,
Externality costs are: environmental, health, water, corrosion.
Externality costs in other countries are estimated to be between 10-50 % of energy costs.
Externality costs should be internalized in the energy costs.
It is premature to implement externality costs without further information on the health and environmental effects of energy use.
Options

- Legislate emissions- costs must be less than benefits
- Include externality costs in energy planning by using cost adders
- Impose energy tax used to pay for externalities. This must be adjusted to reflect energy type and use.

Integrated resource planning includes supply and demand side management, this can be achieved through tariffs, audits, awareness, technical support information and incentives.
When supplier and distributor are separate it is difficult to provide incentives or introduce regulations to encourage DSM.
Due to the lack of competition in the electricity sector a regulatory body is necessary to ensure that supply side management is applied.
An appropriate structure for carrying out DSM should be decided jointly by government, electricity distributors, ESKOM, and individuals with DSM experience.

A mix of policies is necessary because of the diversity of industry, policies should not favour energy intensive industries or the economy will shift towards these.

A comprehensive database is an essential building block in an energy efficiency programme. The database should include; energy statistics, equipment manufacturers and details of energy using equipment, results of energy efficiency programmes, energy prices and tariffs.

Information programmes should focus on; creating awareness, an energy journal, seminars, technical handbooks, advisory services, education and training, boiler testing, plant energy audits, sectoral energy audits and demonstration schemes.

Financial incentives should encourage the use of equipment that is substantially more expensive than a less efficient alternative, but is ultimately cheaper when you consider life-cycle costing. Financial incentives are used as catalysts they are not required to cover the total cost of implementation. Financial incentives can be in the form of grants, tax incentives, loans, rebates, direct installation or import duty relief. It is unlikely that government will have the finance to support these measures, and it is suggested that available funds are allocated to information programmes.

Regulations are only effective if the skills and services are present to support them, this is not the case in South Africa.

Boilers and motors can be easily classified for efficiency standards. In areas where technology is diverse and therefore verification is costly the implementation of standards is unpractical. A common approach therefore is the introduction of voluntary standards.

Results of research must be effectively marketed and distributed. Attention needs to be given to applied research in areas where industry is too fragmented to carry out its own.

Specific areas/technologies to target are

- Electric motors, selection, variable speed drives, standards,
- Cogeneration.

Short term projects proposed by the study are

- A continuously updated national energy database,
- Technical manual on energy management,
- Training programme,
- Boiler testing scheme,
- Subsidized energy audit scheme,
- Sectoral energy audit scheme,
- Demonstration scheme,
- Electric motor efficiency programme.

Finally project implementation phases, targets and financial costs involved are assessed and suggested.

A five year energy efficiency plan was developed in the *Business plan sub directorate energy efficiency* ,1996. Several goals were identified and these are listed briefly;

- Developing support activities,
- Identifying energy efficiency potential,
- Education of children and the inclusion of energy and energy efficiency in the curricula at school level,
- Domestic awareness,
- Improving domestic appliance efficiency through energy labeling programmes,
- Conduct a sectoral energy study, create awareness, conduct audits provide specialized training,
- Improve Commercial building energy efficiency through establishing building standards, increasing energy efficiency in government buildings through conduction audits,
- Equipment energy efficiency improvements,
- Information dissemination, monitoring and evaluation.

A general energy efficiency programme flow chart is developed as well as one for buildings and equipment

To raise awareness, the DME has launched campaigns, held conferences and included energy efficiency in local education. The *Communication programme in the domestic sector phase1& 2* Anna Marie Roux 1998 was launched be the DME to improve awareness in energy efficiency in the domestic sector.

Due to a diversity of attitude and awareness, target groups were identified and messages were adapted to suit their needs. The campaign included a media campaign, interviews, special promotions, information campaign and direct mail campaign this was followed by an evaluation of the project. The campaign was regarded as successful because planned targets were met.

- An energy week was held,
- Enerwizz a mascot character was developed,

- a competition was launched on SABC TV2, the target audience being township children. The aim was to develop an awareness of wise energy usage in the home,
- A taxi net promotion was organized, the objective was to educate commuters about the benefits of saving energy and distribute information material. Campaign information was available in the form of posters and colouring in books and stickers. These were printed in several languages,
- Telephone interviews were used to ascertain the success of the study.

Energy efficiency week, [R Barker, 1999], was launched in South Africa in 1999, this was an education week, the aim being to make energy users more aware of energy efficiency. Information dissemination occurred through Comutanet, street theatres, brochures, media, publicity (television, radio and the printed media) and fuel service stations. The objective was to inform and educate. Target groups were the public, municipalities and local authorities, energy suppliers and distributors, energy consumers, politicians and decision makers, government and the media. The basis of the campaign was

- Publicity,
- Special events,
- Information campaign with an educational focus,
- Direct mail campaign,
- Research and evaluation.

The objectives was to change the attitudes and behavior of consumers, to make people aware of the importance of and benefits of the efficient use of energy. The messages can be simplified as the following

- Awareness of energy week,
- Demonstration on energy developments,
- How to save energy,
- Energy efficient use of all energy sources,
- Energy efficient equipment.

In the area of education, the DME has commissioned the *Development of energy and energy efficiency educational material for the curricula at primary, secondary, tertiary and industrial levels*, Deon van Asewagen, 1999.

This project covers the development of material for primary and tertiary education. Energy modules suitable for the science and technology areas was developed and tested, tasks to be completed that were developed include a small scale biomass model that produces methane. Learning areas cover the natural science area as well as technology. Course material for pilot workshop aimed at tertiary and industrial education are

- Introduction to energy management,
- Energy audit procedures,
- Electrical metering and tariffs,
- Power factor correction and demand control,
- Electric motors,
- Lighting systems,
- Air conditioning and refrigeration,
- Insulation,
- Fans,
- Pumps,

- Compressed air systems,
- Boiler and steam distribution,
- Hot water systems,
- Heat recovery systems,
- Financial analysis.

Teaching will be in the form of three, 3 day workshops.

In the area of assisting companies improve their energy efficiency through energy audits and the provision of services by ESCOS the *Strategy for the establishment of an energy performance contacting (EPC) industry in South Africa* [JP Meyer, 1997], was conducted.
Energy performance contracting refers to the implementation of energy efficiency through performance contracts. ESCOS cover the capital cost of implementing energy efficiency measures and are paid from a portion of the savings. The ESCO will carry out an energy audit, recommend measures to adopt, and implement them.

The services provided by ESCOS should include an energy audit, financing arrangement s, purchase installation and maintenance of installed equipment, training of personnel involved in maintenance and monitoring the operation of equipment to ensure the continuation of savings.

There are several companies that will help to improve the energy bill of the client through tariff negotiations, this however does not improve energy efficiency. Demand side management is an activity covered by ESCOS, however this should not be their main objective, the main objective must be that of improving energy efficiency.

Ackerman from the consulting engineering company Claassen Auret Ackerman was responsible for implementing a shared savings project using energy management systems in government buildings. The department of Public works in Pretoria authorized the consulting engineering company GH Marais and partners in Cape Town in 1995, to implement a shared savings project.

A large American company EPS that deals with financing large energy performance contracts were planning open an office in South Africa, but have recently decided to refrain from doing so due to poor understanding locally of performance contracting.

The benefits of performance contracting associated with improved energy efficiency are the following

- Reduce the countries reliance on external energy resources,
- Offer market sectors an opportunity to upgrade facilities,
- Improve the economy by cutting operating production costs,
- Allow increased industrialization,
- Increased employment,
- Improve energy efficiency without incurring the costs,
- Help create a local energy service industry,

Methodology for the establishment of a subsidized national energy audit scheme MG de Villiers et al, 1996

The report highlights ways to stimulate energy auditing activities by creating awareness and through facilitating the development of energy management and training and

education facilities. Subsidized energy audits will encourage companies to make use of energy audits, they will also encourage the growth of energy auditing services. A 50% subsidy of energy audits is recommended in order for them to be effective. The requirements for an energy audit to be subsidized are suggested as being

- Over R1000 monthly energy bill
- The audit must be carried out by an accredited consultant
- It must fulfill some identified basic requirements

Energy audits should identify ways to reduce energy use and reduce the cost of energy to the industry. Energy audits covered in South Africa between 1990 and 1994 include the brick, brewing, textiles, paper, metal and food industries. A study in the USA showed that fully subsidized audits marketed over the phone or personally or by mail enjoyed a success rate of between 37 and 50%. Unsubsidized audits marketed by phone or mail had a success rate of 9%.

Subsidy structures for energy audit schemes are suggested, these vary depending on the amount of the energy bill.

Energy audits are a vital source of energy information. They can be used to verify existing energy end use data, and identify common opportunities to improve energy efficiency. For these purposes it is recommended that a database of energy audits be developed.

The report covers experiences of industrial energy audit schemes in Australia, Canada. Egypt, India, Kenya, Taiwan and the UK.

Development of a business plan for an energy efficiency agency LHA Management consultants, 1998

The report covers a survey of international energy efficiency agencies, an analysis of South African stakeholder needs, and the development of a business plan for an energy efficiency agency.

Several countries world wide have national energy efficiency programmes, the experience of ETSU is that "… autonomous agencies have proven to be the most effective programme implementing organizations". Examples of these organizations are the Australian national energy efficiency programme, The Energy efficiency conservation authority of New Zealand, Netherlands agency and the environment (NOVEM), American council for an energy –efficient economy (ACEEE), Norwegian Industrial Energy Efficiency Network, Canadian Energy Research Institute (CERI) and the Programme for Electricity conservation (PROCEL, Brazil).

There is a joint United Nations Development Programme (UNDP) and the World Bank programme to establish energy efficiency agencies in developing countries, work is carried out by the Overseas Development Administration and The Energy Sector Management Programme.

The suggested approach towards achieving the aims is

- Motivate the energy user towards energy efficiency
- Take into account the needs for the user
- Top down approaches are generally unsuccessful
- The approach should

- Raise awareness,
- Begin by implementing low cost measures,
- Maintain savings,
- New investments must be in energy efficient technology.

The context for national energy efficiency programmes will have a number of key thrusts and these must be implemented strategically with long term goals and commitment in mind. The programme must be well managed, by a well respected skilled organization separate form government policy forming. Monitoring to evaluate improvements in energy efficiency at a national level or individual level is essential. The tools used to implement programmes must be selected according to cultural issues, social and economic factors that are specific to South Africa.
Energy efficiency centers are developed to provide policy advice and create incentives for energy conservation. They could assist in identifying investment opportunities and partners for joint ventures in key energy technology and service areas. They will coordinate and support activities. They could run demonstration projects and training to educate the public and industry.

Sector wide reform and economically efficient pricing are key conditions for end use energy efficiency. Electricity pricing in the developed and developing world differs, the developing word tends to price low and often does not cover costs, the developing world price tends to reflect the cost of producing electricity accurately and providers often not only cover costs but also make a profit. It is important that resources and skills are developed locally; this is the best way to ensure that programmes that are implemented are not short lived. Projects will only receive finance when investors are provided with adequate security that there will be a reasonable return on investments.

The objective of the agency would be to provide
- Technical assistance,
- Technical and financial intermediation,
- Policy analysis and support.

Reasons for possible failure of the association were sited, these were given by
- Industry
  - Technical assistance would not be asked for from an association that did not have intimate knowledge of their operations
  - The agency would need to focus on lowering costs
- Academic and research organizations
  - A lack of clear objectives
  - Role limitations
  - Loss of national perspective as the agency is forced to be self-sufficient
  - Red tape
  - Lack of vision
- NGO's
  - Possible vested interest of stakeholders
  - Consumer apathy
  - Funding required from government would should be longer than 8 years

A detailed report of projects completed prior to 1992 are summerised in the *Synthesis of national energy efficiency research*, excluding transportation energy. The projects covered are listed below;

Cape low energy experimental housing project (CLEEHP), Forrest S Higgs, J.W. Hand., 1988
Onderseok na die passiewe ontwerp van lae hoogte kantoor-geboue Prof D Holm, 1987
Micro-computer design packages for energy efficient buildings, A Eberhard, 1988
Potential of electrically operated head pumps for heating water in South Africa, A johannsen, G Kaiser, 1984
A review of striling engine development and applications, I.S. Myburgh, 1983
International electric load conservation-literature survey, L Harper, 1984
Quick energy auditing for industry, N Tully, M.R. Lockett, 1990
Energy utilization in South Africa, A.C. Huggett 1986
Potential for heat recovery in South Africa, G Kaiser, A Johannsen, 1987
Development of an energy efficient dryer, G.J. Mostert, E.F. Faber, 1988
Potential for the conservation of energy in South Africa, A.T. Williams, 1986
The application of demand side management by municipalities in the RSA, A.C. Huggett, Y Blompamp, 1988
The potential for electric load and electricity conservation in South Africa J.S. Gervais, 1985
Comparison of boiler/steam turbine generating sets with alternative power generation equipment for use in remote areas, M.M. Armstrong, R.S. Bowden, 1989
Energy audits for phosphate fertilizer and sulphuric acid, C.J. Els, 1988
Energy audit of the South African Timber industry, JD Weys, H Riekert, 1988
Energy utilization in South Africa: a comparison with international analysis, A Pouris, R.K. Dutkiewicz, 1986
Computer modeling of a structural storage air-conditioning system, C.C. Doyle, A Johannsen, 1989
Potential of ice/chilled water storage for air-conditioning systems in South Africa, A. Johannsen, G. Kaiser, 1989
An overview of the energy –efficient use of electrical motors in the RSA, L.R. Olivier, 1988
Energy conservation and integration in a chemical plant, Dr D.M. Fraser, 1991
Energy audits for phosphoric acd, Nitric acid, ammonia and nitrogen containing fertilizer manufacture in the RSA, N Boegman, 1990
Technical and economic change in the South African steam boiler stock, R.K. Dutkiewicz, P.C. Botha, 1991
Wet/Dry cooling for industrial applications, Prof P.J. Erens, A.A. Dreyer, D. Kriel, 1990
Stimulation of electricity intensive industries, E-A Uken, 1989
Absorption refrigeration using waste heat, G.Vicatos, 1989
The analysis of the potential for demand side management by municipalities with Cape Town as a case study, J.J. Anderssen, F.S. van der Merwe, 1989
The effect of various levels of market penetration of domestic hot water heat pumps on electricity demand, J.L. Coetzee, 1990
Die markpotensial ven hittepompe in Suid Africa, G.P. Gretvenstein, J.L. Coetzee, 1990
Demand side management development database and knowledge tools, Prof I.E. Lane,
Thermal performance of buildings, C. Lombard, 1989
The South African heat rejection market, L.H.A. management consultants, 1990
Evaluation of energy and demand efficiency of major domestic electric equipment, E.A. Uken, N. Beute, 1991
The effective use of energy in westernized dwellings, E.A. Uken, n. Beute, 1992

The above also divides the projects into three themes, collected and analyzed energy information, Developed design and decision support tools, and demonstrated energy efficiency improvements.

Projects covering sectors of the economy and their use of energy that have been completed recently are:

- Market survey of the textile industry, 1997; This survey gives a brief summary of the processes involved in textile manufacture and the energy used in manufacture of textiles in South Africa. It also looks at the fuel use in the textile industry in South Africa compared to that of Zambia and Swaziland. The project focus is to supply the DME with the necessary information to launch an awareness campaign in the textile sector. It describes the current status of energy management in the textile industry as being highly fragmented. Energy management is not a key performance area. Recommendations in the area of energy efficiency are generally made by middle and operational management, the final approval rests with senior management. The report also covers areas to where energy efficiency could be improved
- Development of a working document for the National domestic energy efficiency (NADEE) task team.
- Energy audits of the Pulp and Paper Industry 1986
- Energy audits for three sectors of the chemical industry 1986
- Energy audits of the timber processing industry 1986
- Energy integration and conservation on a chemical plant 1986
- Energy management at Sawmills 1988
- Review and analysis of energy use in the metals sector 1991
- Energy audits in the food industry 1993
- Energy savings potential and guidelines for effective energy use in office buildings
- Energy efficiency measures for the domestic sector

Projects covering equipment

- Overview of the energy efficient use of electric motors in South Africa
- Absorption refrigeration using waste heat 1988
- Heat pump market survey 1988
- Effects of hot water cylinder design on energy utilization 1989
- Energy saving through natural ventilation in buildings 1990
- Computer aided design and management of energy efficient buildings and HVAC systems as well as their control

Projects covering methods of implementing energy efficiency

- Demand side management development of database and knowledge tools
- Potential for cogeneration and small scale independent power production in South Africa
- DSM options for supply authorities in manufacturing sector
- Load audits and stimulation to develop demand side management potential in the mining sector in mines
- DSM management options for formal domestic sector
- Methodology for energy audit scheme 1994
- Development of an energy project management system 1998

Other energy efficiency projects completed to date:

Energy implication of modal shift from buses to combi taxis, Tomecki, A.B, 1994

Based on energy requirement per passenger, a bus is more efficient than a combi taxi. The unprecedented growth of the combi taxi industry has a major impact on bus companies and considerable implications on fuel consumption in urban public transport. The current trends in the use of transport modes and the attitudes of passengers were examined. Four possible scenarios were proposed considering various modal shifts: from buses to taxis, from taxis to buses, from cars to buses, and from cars to taxis. A model was developed which enables fuel consumption per passenger to be estimated for a target year for each scenario. The conclusions leading from the analysis of these scenarios, with the target set at the year 2000, are presented. A strategy needs to be developed to encourage both bus and combi taxi use and to reduce the use of cars; this will improve the traffic situation, congestion will not increase and fuel efficiency will be considerably improved.

Energy utilization in tractor-implement operation, Lyne, P.W., L.Bartels, R.F.Hansen, A.C.Meiring, P., 1990

Mechanization, and in particular the tractor-implement combination, is a prime target area for improving production efficiency in agriculture. Earlier research in this field has only involved the performance of the tractor. This project aimed to investigate the cost savings in terms of time and fuel that could be achieved by optimizing the adjustments of the tractor-implement combination during field operations. Operating parameters such as speed and depth of operation were varied to achieve increased work rates and reduced fuel consumption. This was performed while striving to ensure that the tillage quality was not adversely affected. Quantification of tillage quality was the most difficult part of the project.

The local content programme and vehicle tare mass., Poree, N.A.,1985

The report presents the results of an investigation into the local content programme for the manufacture of light vehicles in South Africa, with particular reference to the incentives and disincentives which the programme offers manufacturers for the reduction of tare mass. The implications of these results for fuel conservation are discussed. The differences in the duty-related incentives for motor cars and light commercial vehicles are identified and described.

Fuel conservation manual for road transport managers, Poree, N.A..Walters, J, 1991

This manual of fuel conservation practices for road transport managers is a summary of research findings and reports in the literature from the fields of automotive engineering, management accounting, industrial psychology, business management and statistics. As a practical manual on the management of energy efficient road transport operations, it is intended for dissemination to road transport practitioners as part of the National Energy Conservation Programme.

Issues impacting on the efficient use of energy in transportation: Part 2. , Mirilees, R.I., 1993

The transportation models discussed in the report are all concerned with the demand for transport, and hence transportation energy, for a given supply of transport infrastructure. More specifically, such models determine the demand for transport by mode, by origin-destination and by route for a given transport network and transport cost. Transport cost includes the supply of energy in terms of energy prices. Due to the strategic importance of energy in South Africa, a new requirement emerged, namely to produce a functional macro petrol and diesel demand model to assist decision makers in the planning and management of this strategic resource. It was decided to develop models for petrol and diesel demand forecasts that are less data intensive than those developed at the Massachusetts Institute of Technology, by using the relationships identified through graphical analysis. These new models indicate the trends of future fuel

How to save petrol., Uken, E.A.1990

The booklet provides motorists with hints on saving up to 20 percent on their petrol bills.

Relative energy efficiency of transport modes: development of energy efficiency indices, Stanway, R.A., 1992

Several major urban transportation studies are being undertaken, but few consider the energy efficiency of alternative modes of transport. It is important that decision-makers responsible for transportation policy and investment are aware of the energy efficiencies of the various modes available to perform transport tasks and of the suitability and efficiency of a particular mode in performing a specific task. This project therefore aims to determine and compare the relative energy efficiencies of all transportation modes for both freight and passenger transport. Acceptability and emission levels for all transportation modes were also determined.

Alternative communication approaches to promote effective and efficient energy use in the domestic sector, van Eeden, A., 1991

The project investigated methods of influencing energy use behaviour in the domestic sector. McGuire's systems approach to persuasive communication was selected since it gives the campaign planner total control during the planning, implementation and evaluation phases. An evaluation of local and international campaigns in several first and third world countries proved the importance of research and control in the planning, implementation and evaluation phases of the campaign. It also provided practical examples of persuasion techniques that were successful and those that were not. Based on this knowledge, guidelines were developed for a persuasion campaign aimed at the domestic market. The market was segmented and frameworks for messages were developed, the media to be used were identified and a timeframe for the achievement of the various outputs in the persuasion process was suggested. The framework can be applied to other energy sectors.

Computer aided demand and energy management systems in the gold mining environment. Lane, I.E., van Jaarsveldt, A.Z.A., Hoogenboezem, J.J., 1987

Because there are so many demand-side management (DSM) alternatives, the identification of potential alternatives is difficult. The main objective of this project was to integrate a computer-aided demand and energy management system at a large gold mine complex as a DSM alternative. The conventional method of DSM in the gold

mining environment is outlined. An improved approach, a computer-aided demand and energy management system (CADEMS), is proposed to ensure an improvement in the load factor without production loss through unplanned load interruptions. The report describes the application modules of CADEMS designed to provide more effective load scheduling and control strategies which may be used to reduce electricity costs. The six modules are designed for: energy reallocation; incentive-based cost allocation; power management information; short-term load forecasting; interactive load scheduling; and maximum demand monitoring.

National commercial energy consumption summary, excluding liquid fuels, 1991. Cooper, C.J., 1993

The report presents a summary of energy demand (excluding liquid fuels) for South Africa for the years 1989, 1990 and 1991 by economic sector (manufacturing industry, transport, domestic, mining, commerce and agriculture). From the end-use data it is shown that thermal applications are the most important, followed by transport and mechanical applications. The geographical distribution of energy demand is presented in tabular form.

Energy consumption in First World houses in SA, Part 1. Literature review and questionnaire design. van Rensburg, D.B.J., 1993

A national picture of how and for which purposes energy is used in the developed (First World) household sector of South Africa does not exist, hampering the development of an energy efficiency policy and strategy for such households. Against this background, this project aimed to create a database and analysis of energy consumption in First World houses in South Africa. Emphasis was placed on the various forms of energy consumed and the types of energy-consuming appliances used.

Energy efficiency indicators for South Africa. ,Dutkiewicz, R.K., 1993

The energy indicators required for an adequate analysis of energy trends for policy purposes are discussed. It is shown that a relationship exists between economic activity and energy demand, which allows the construction of scenarios of energy demand for various economic growth rates. Energy intensity, the ratio of energy demand to economic activity (Gross Domestic Product) is a good parameter for studying energy demand, but it must be applied at the disaggregated level for it to be meaningful. Besides the traditional desegregation into industrial, transport, agriculture and commercial sectors, further desegregation of the industrial sector is proposed. Since energy intensity changes with technological advances and the adoption of more efficient methods of energy use, secondary indicators are necessary to note trends in energy efficiency. An index of the level of energy import reliance in South Africa is also needed.

An integrated design tool for naturally-ventilated buildings. Rousseau, P.G., 1992

The development of an integrated design tool for naturally- ventilated buildings is described. The tool consists of a thermal model and a flow model and takes into account the important interaction between these two. The flow model is based on the concept of a flow network where openings are represented by non-linear flow resistances. The model draws a balance between purely theoretical equations and empirical data. The applicability of the new tool is illustrated through a number of case studies, from which it is clear that considerable energy and cost savings may be

realized through efficient use of natural ventilation in buildings. From a number of measurements in real buildings, it was established that the results obtained with the new tool are sufficiently accurate for design purposes.

Indirect evaporative cooling for air conditioning. Erens, P.J., Dreyer, A.A., Mercker, J.H., 1992

The main advantages that indirect evaporative cooling has over conventional vapour compression systems for air conditioning are: low running costs; low initial costs; mechanical simplicity; and no water vapour is added to the air stream entering the conditioned space. A mathematical model for the analysis of indirect evaporative air coolers was built into a computer simulation program, which was verified by an experimental study on a typical indirect evaporative cooler using dimpled plastic plates as the heat exchanger surface. Another program for the simulation of indirect evaporative coolers using conventional heat exchangers and cooling towers was also developed. Room air can be used regeneratively in both of these programs to improve the cooling effect achieved. Some comments on the applications and suitability of climatic areas to the use of evaporative cooling and on the organizations most likely to benefit from this.

Energy utilization in the domestic sector. Stone, A.J., 1979

Information is available on how much energy is supplied to the domestic sector but little is known about how this energy is used. The aim of the project was to gather information on this area of domestic energy use. In-depth analysis of rural domestic energy utilization was not possible owing to lack of data. Energy use patterns for the rural domestic sector as a whole were however established. Based on the results of the survey and population predictions, future energy patterns are estimated.

A new computer program for the design and management of energy efficient buildings and HVAC (heating ventilating air conditioning) systems as well as their control: a totally new approach. Mathews, E.H., 1993

The aim of the project was to develop a new tool for the design and management of energy efficient buildings and indoor climate control systems. The new tool allows the building and heating ventilation air conditioning (HVAC) system designer to investigate the passive performance of any building situated in any climate and to investigate low-energy cooling strategies such as natural ventilation and evaporative cooling. It also allows for load predictions and cooling coil analyses based on peak loads. This analysis provides the essential information needed for the design of any active HVAC system. Once the system has been specified, the tool also allows an integrated simulation of the building, the HVAC system and its controller. The integrated simulation is essential in determining the energy savings potential of load reduction strategies, such as roof overhangs and insulation, whilst combined cooling strategies can also be investigated.

National energy efficiency policy synthesis study. Dykes, A.R., 1994

A synthesis of current and future policies, attitudes and priorities regarding the effective use of energy in stationary applications is produced. A survey of 111 countries indicated that only ten countries have higher energy intensities than South Africa. Whilst various reasons for this are given, this fact indicates clearly that energy efficiency requires

urgent attention in South Africa. Past and present national energy policies are reviewed, showing that emphasis is gradually changing from the adequate and uninterrupted provision of energy to the efficient use of energy. Local and international developments are traced, in particular the shift in the OECD countries from energy saving to environmental protection as the motivation for energy efficiency. Constraints, problems, weaknesses and gaps are discussed; the most prominent are the relatively low energy prices, electricity generation overcapacity and lack of government commitment.

Energy consumption in First World houses in SA, Part 2. Statistical analysis of results. van Rensburg, D.B.J., 1993

A national picture of how and for which purposes energy is used in the developed (First World) household sector of South Africa does not exist, hampering the development of an energy efficiency policy and strategy for such households. Against this background, this project aimed to create a database and analysis of energy consumption in First World houses in South Africa. Emphasis was placed on the various forms of energy consumed and the types of energy-consuming appliances used. Ninety-four percent of the total energy demand is derived from electricity. The other six percent is made up by charcoal, wood, bottled gas, anthracite, petrol, coal, municipal gas and fuel oil. Dwellings use about 9 300 kWh electricity per year at an average cost of R110 per month. Appliance penetration and usage corresponds with that expected of First World dwellings, with a strong correlation between income group and the use of specific appliances.

Potential of non-azeotropic refrigerant mixtures for water-heating heat pumps in South Africa., Johannsen, A.F.B., 1992

A theoretical investigation into the use of non-azeotropic refrigerant mixtures in water-heating heat pumps under South Africa conditions is presented. The operating characteristics of the refrigerant mixtures and heat pumps are reviewed and the requirements for both the refrigerants and heat pumps are identified. A non-azeotropic mixture of R22 and R142b is selected, as environmentally-acceptable, commercially-available and fully-compatible with materials and lubricants used in current heat pump designs. An analytical evaluation of the performance of a particular heat pump operating with the mixture, under varying operating conditions, is presented. A proposed advanced heat pump, featuring a facility for varying mixture composition, an electronic expansion valve and a microprocessor-based control system, would be capable of producing high-temperature water at high efficiencies for most of the year in South African conditions.

Quick energy auditing for industry. Tully, N., Lockett, M.R., 1990

A Quick Energy Audit (QEA) is a short investigation of every aspect of energy utilization within a factory and comprises an analysis of historical energy records and accounts which, together with a physical inspection of the plant, will identify energy and cost saving opportunities. This differs from a full or in-depth energy audit, which will entail a detailed analysis and re- evaluation of every item of energy-consuming equipment, together with comprehensive measurement and testing. This report specifies the methodology for a Quick Energy Audit as simply and concisely as possible, to allow technical and semi-technical personnel to understand how to perform such an audit.

Residential end-use electricity monitoring: Cape Town case study. Anderssen, J.J., 1994

The report presents the findings of a study into residential appliance end-use electricity loads by direct metering, the intention being to test all the ingredients of a full-fledged study to find the lowest cost alternatives. The report covers statistical sampling techniques to select the locations for metering, the requirements for and testing of the most cost-effective monitoring instrumentation, and installation methods. In the absence of data analysis software specifically aimed at this type of application, the report sets out the data processing steps which can be followed to ensure that quality data are gathered. The requirements for data processing software, which needs to be developed to accelerate the data manipulation process, are specified. Useful information on appliance end-use loads was obtained in the course of the study.

A review of available micro-computer design packages for passive solar design of low cost dwellings. Back, D., 1989

The objectives of the project were: to review microcomputer-based software, currently available in South Africa, the United States and Australia, for passive solar design of buildings; to select an overseas software package best suited to passive solar design of low-income dwellings in South Africa; and, if necessary, to adapt and customize this software for South African conditions. The report outlines the essential principles in passive solar design in relation to orientation, form, fabric and the mass of buildings. The concept of optimum thermal comfort level is discussed. The key thermal processes in the science of passive solar design are identified and mathematical models are classified according to their basic approach: thermal networks, weighting or transfer functions, and harmonic analysis. Computer-based design tools for passive solar buildings are classified as simulations or correlations.

Review and analysis of energy use in the metal industries. Part 1, Ferroalloys. Granville, A., Freeman, M.J.,1991

Ferroalloys production is a particularly intense user of energy. For example, in the manufacture of ferrochrome energy accounts for over 60 percent of direct operating costs. The report emphasizes the importance of technological development to optimize methods and production efficiency in ferroalloy production. The factors determining present and future energy demand for ferroalloys, and the effect of expansion of ferroalloy production on energy requirements in South Africa, were investigated. Alloys of chromium, manganese and silicon are discussed in detail with special attention placed on ferrochrome, while data are given also on chromium, manganese and silicon metals, nickel, vanadium, titanium and calcium carbide. The report discusses the structure of the ferroalloy industry in world and South African terms. Energy consumptions in the production of ferrochrome are discussed in detail, contrasting various processes and their variations.

A review of development and application of heat pump technology., Johannsen, A., 1984

The current state-of-the-art of heat pump technology is reviewed. Discussion of basic heat pump cycles, their practical implementation, and the extent of use of different heat pump systems in different countries is discussed. Recent trends in current R & D on advanced heat pump systems are also discussed. In South Africa the most promising

uses of heat pumps would appear to be for water heating in medium to large installations, for space heating in combination with air conditioning in commercial buildings, and for heating and drying in industry. The establishment of a standard for testing heat pumps, and demonstration projects involving different heat pumps in different applications, are recommended.

Status study on energy efficient lighting., Leuschner, F.W., 1992

The project studied lighting technology as practiced overseas and in South Africa to determine the potential for saving energy by adopting energy efficient lighting designs, habits, incentives and regulations. An overview of light and lighting principles is presented. Current light sources, lighting equipment, codes of practice, lighting designs and daylight in overseas countries and in South Africa are described. Future activities in energy efficient lighting are reviewed, including natural trends that may occur and proposed actions to promote energy efficient lighting in South Africa.

Photovoltaic research and demonstration project., van Niekerk, H.R., 1989

The project aimed to assess the performance characteristics of a photovoltaic electricity generation system when providing the energy requirements of a farmhouse. Aspects such as daily energy supply, efficiency, battery behaviour, energy losses, voltage and current variations, reliability, component dimensioning and the performance of a diesel generator (previously used to provide the electricity) were investigated. It was concluded that the highest possible efficiency should be sought in the energy conversion process, particularly the DC to AC conversion. If possible, energy from the storage battery should be used directly. Correct component dimensioning should be maintained at all costs (average energy supply should exceed average load demand by a sufficient margin) to ensure a high average state of charge of the storage battery. If a standby diesel generator is used, the batteries should be charged when the generator has to provide (continued).

Social determinants of energy use in low-income households in Durban., Jones, S., Aitken, R.,Dladla, J., 2000

This study documents and compares patterns of domestic fuel use in four low-income settlements in the broader Cato Manor area of Durban. These four settlement types were a long-electrified formal township, largely in electrified backyard shacks, an un serviced informal settlement, and a site-and-service settlement in the process of electrification. The study ran from April 1995 to March 1998. It made use of both qualitative and quantitative research techniques.

Part I of the report serves as an extended introduction to the study. The first chapter details the objectives of the research, introduces the research location, and provides a brief outline of the ensuing chapters. Chapter two describes the various methodologies used in the study, focusing particularly on issues relating to the samples. The last chapter in Part I, Chapter 3, serves two purposes. The first is to set the scene by outlining the history, infra structural features and social character of each of the housing-settlement types in which the research was conducted. The second is to summarises some of the core findings of our preliminary report so as to provide continuity between it and the present one.

The chapters in Part II respond to the enabling outputs as specified in the project brief. The first two chapters, Chapters 4 and 5, present the authors findings in respect of fuel-use and appliance use patterns, as well as data on energy expenditure.

Chapter 6 deals with multiple fuel-use, fuel-substitution and fuel efficiency.

The next three chapters, Chapters 7, 8, 9, shift from the intricacies of fuel-use itself to the broader household and community level contexts in which such use occurs.

Chapters 10 and 11 deal with issues which are related as much to constraints placed on fuel-users by the physical structure of dwellings themselves as to knowledge, ignorance and behavioral factors.

The progress made in respect of organisational capacity building and community capacity building is discussed in chapter 12, where the authors place particular emphasis on a series of participatory workshops which they initiated and facilitated in Cato Manor.

The last chapter, chapter 13, examines the effects on the four communities of aspects of local, regional and national energy policy and service provision.

Chapter 14 summarises the major findings and conclusions of the study.