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**A Proposed Methodology for the
Gathering and Dissemination of
Household Energy Information in
South Africa**

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**Submitted to the University of Cape Town in partial
fulfilment of the requirements for the degree of Master
of Philosophy in Energy Studies**

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Energy and Development Research Centre

University of Cape Town

DECLARATION

I, Eugene Fultner Visagie, submit this dissertation to the University of Cape Town in partial fulfilment of the requirements for the degree of Master of Philosophy in Energy Studies. I declare that, unless otherwise acknowledged, this to be my original work and that it has not been submitted in this or similar form for a degree at any University.

Signed by candidate

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ABSTRACT

The aim of this study was to develop a methodology that would cost-effectively supply reliable and up-to-date household energy information that can be utilised by energy policymaking and planning.

One of the most serious constraints faced by energy planners and policy makers in developing countries is the absence of a systematic, comprehensive and structured household energy information system. A system of this nature, which requires regular updating, is a prerequisite for meeting the challenge of poverty alleviation.

During the apartheid era, the only available household energy information was that of commercial fuels (oil, gas, coal and electricity), used mostly by industrial and commercial sectors and Whites households. The majority of Black households used traditional fuels (fuelwood, paraffin etc.) for which no information was available. The present government has also not managed to devote adequate resources to this gap in data gathering and analysis, the important first step in developing energy policies and strategies.

This thesis is an attempt to address this shortcoming, effectively by proposing that high school learners be engaged in household energy data gathering and dissemination with the objective of supplying reliable information cost-effectively for energy planning and policymaking. However, this study has also shown that this is only possible if preceded by a programme of energy education. The reasons for which energy education must be integrated with the school curriculum have been explored in the thesis.

As a result of this research reliable, up-to-date household energy information was gathered cost-effectively. Learners benefited educationally and this in turn would equip them to make more rational decisions about energy production and usage in the future.

Information gathered and knowledge about this methodology should be conveyed to local authorities, regional and national governments through appropriate structures in order to explore the potential of its extension to a larger scale implementation.

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1. INTRODUCTION

1.1 BACKGROUND

One of the challenges facing the energy sector in South Africa is the formulation and implementation of an effective strategy for obtaining reliable and up-to-date energy information, especially in the household sector. The problem is that national energy data is either non-existent, or qualitatively unreliable and thus unusable (Afrane-Okese 1998: 1). The International Energy Agency (IEA) has identified the lack of reliable and up-to-date energy data as a major weakness in the energy policy-making process in South Africa (DME 1998: 95). Such information is crucial for accurate development planning and also improves the decision-making process. Policies and planning strategies poorly informed about people's energy-use patterns, access to energy resources and levels of income, would do the people more harm than good. Energy is critical because of the vital role it plays in economic and social development.

During the apartheid era, energy data collection was largely confined to commerce and industry – mostly commercial fuels used by the privileged sector of society who were mostly Whites. Most Black households, on the other hand, used traditional fuels (mainly biomass) for cooking and heating. As a result of the extreme secrecy that governed the energy sector during the apartheid era, there was no commitment by the government of the time to collect and publish data on this sector, which would have allowed or facilitated the development of sound and balanced energy policies (Eberhard and Van Horen 1995: 16-18). Energy services for low-income households have moreover never been adequate, as the past government's emphasis was on creating a modern industrial society to meet the needs of an industrial sector and a privileged White minority (DME 1998: 13).

The social, environmental and health costs of these policies were enormous. There is a huge social burden on women and children in rural areas to collect fuelwood from far distances. Low levels of access to electricity means that many people are denied the convenience and improved quality of life that comes with the use of electric appliances (Afrane-Okese 1998:1-2). Poor households use mostly paraffin, coal, fuelwood and candles to meet their cooking, entertainment and lighting needs. Moreover, these houses are poorly ventilated which leads to many environmental and health hazards.

The household sector has mostly been neglected in terms of energy information gathering. At present no systematic, comprehensive and structured system of household energy data collection and dissemination exists in South Africa (Visagie 2001: 30).

According to Prasad (1994: 4), with reference to the Indian experience, information on biomass use for energy purposes is about seven years old and there are inconsistencies in statistical information. Even the World Bank data on commercial energy are roughly two years old (ibid: 4). Moreover, the present procedures of survey practices are inadequate to quantify biomass use. These practices are prohibitively expensive, especially for a developing country such as South Africa, which furthermore does not have a developed infrastructure to gather and disseminate energy data as for example in the United States of America.

Prasad (ibid: 4) states that instead of dreaming up hypothetical exercises to teach mathematics and observational skills, it might be much more useful to use the pupils as collectors of energy statistics. In this way, the energy database and local awareness of energy problems could be substantially improved.

This idea is supported by a World Energy Council (1999: 100) report, which stated that it would make sense to attempt to incorporate this type of survey work into school curricula. For instance, much of the good quality data on household energy use in developing countries has come from small-scale surveys, which are geographically specific (ibid: 34).

A further important lack of information is the one felt by rural people themselves. Although they know a great deal about traditional energy supplies and end-use options, very few know about the potential of new technologies and modern fuels, making it difficult for them to contribute meaningfully to much of the planning process. Increased access to information has the potential to redress this (ibid: 101).

Study Objectives

This thesis attempts to explore a new methodology for gathering and disseminating information on energy use with the objective of achieving two main goals:

- To create a cost-effective method of obtaining more accurate and up-to-date energy data using school learners as opposed to that obtained through conventional methods of collecting and disseminating energy information and
- To promote an energy-conscious and educated society equipped with critical thinking and problem-solving skills to make educated decisions in the future.

1.2 VALUE OF THE RESEARCH

Student participation in energy data collection would not only provide much needed information, but would also offer them educational value in return, namely a grounding in elementary social science methods and a means of contextualising science and mathematics. By enhancing their awareness and understanding of energy-related issues and challenges,

learners would moreover be better equipped to seek rational and practical solutions to these problems.

The American National Energy Strategy (1991: 206) states that the key to developing human resources in energy fields is education – not just in the narrow sense of teaching citizens about energy topics, but in the broad sense of instilling in young people and adults a foundation of scientific knowledge, a context in which energy issues can be evaluated.

Schools are also ideal venues for the dissemination of energy information to learners and the broader community. Repeated surveys by learners to give time-series and location-specific data would thus be invaluable to energy planners and policymakers, especially at local government and community level. In this way the national and regional household energy database can be kept up-to-date.

1.3 RESEARCH METHODOLOGY

Firstly, a literature review of current publications on the subject of household energy information collection and dissemination was undertaken. This was supplemented by literature reviews on energy education in Industrialised and Less Developed Countries (LDC).

Secondly, data was collected in various stages:

Initially required information about energy use was obtained from learners and teachers through semi-structured interviews. This was based on the assumption that these target groups had the requisite insight, experience and invaluable information.

Thereafter, questionnaires for capturing the required information were designed for both learners and teachers. The aim of this was to ascertain their understanding and perceptions of energy-related issues. A combination of open-ended and closed-ended questions were used in the questionnaires, with the former providing opportunities for participants to express their own views on these issues.

The proposed methodology entails the engagement of learners in energy educational activities, and household energy information gathering and dissemination with the objective of supplying reliable information cost-effectively for energy planning and policymaking.

The study focussed on Grade Ten to Twelve learners from Ocean View High School situated in Ocean View, a suburb of Cape Town. This group was targeted because of their level of maturity and intellect.

To ensure the validity and reliability of the methodology, a pilot study was conducted first to help iron out problems with the research strategy and to make the necessary adjustments. Twenty three learners from Masimaphumelele, an informal settlement near Ocean View,

completed the household energy information questionnaire to ascertain the relevance of the questionnaire to their specific community circumstances and to address problems concerning language and conceptualisation.

Learners actively participated in the analysis of the data. As a task learners interpreted the information, made graphical representations, debated issues and offered solutions to some of the challenges facing their specific community, school and the broader society.

1.4 KEY QUESTIONS

The following key questions were examined in this study:

- Why is it important to know the use of biomass and other household energy sources or fuels more accurately than is known now?
- To what extent can energy education contribute to energy information gathering and dissemination?
- What is the difference in the level and scope of energy education between Industrialised and Less Developed Countries?
- What is the nature and relevance of the South African household energy database to energy policymaking and planning?
- In what ways can school activities be used as tools for energy information gathering and dissemination?
- To what extent does this methodology of using learners for energy information gathering potentially and practically have the validity to achieve the objectives of creating an energy-educated society and supply more accurate energy information in a cost-effective manner? What are the possible limitations of this method?

1.5 STRUCTURE OF THESIS

Chapter One is a short introduction, which provides the background to the present study, its objectives and the methodology used.

Chapter Two discusses the value and use of energy information and assesses how a process of energy information gathering and dissemination through integrated energy planning enhances social equity, environmental sustainability, and economic competitiveness and energy efficiency.

Chapter Three discusses energy education as a theme in school curricula and community development, by focusing on the level and scope of energy education in Industrialised and Less Developed Countries respectively. It is important for us to learn from experiences in other countries.

Chapter Four gives an overview of energy information gathering and dissemination in South Africa to date and discusses the current level of energy education.

Chapter Five firstly evaluates and analyses the application of the proposed methodology (see 1.3) to cost-effectively, timeously and more accurately supply household energy information, and secondly assesses the impact of the energy education programme on the learners and the broader school community.

The final chapter, Chapter Six, summarises the findings and makes certain recommendations.

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2. ENERGY DATA GATHERING AND DISSEMINATION: A TOOL FOR DEVELOPMENT

2.1 INTRODUCTION

Policies and planning strategies that improve the poor's access to reliable and improved energy services can make an important difference to their welfare (Townsend 2000: 8). The Sustainable Energy Programme of the Shell Foundation concurs that there is a link between access to energy services and social and economic development. In fact, without such access industrialised nations would not have achieved their current affluence (Shell Foundation 2001: 1). What is the starting point for improving access? What are the kinds of improvements that poor households and communities value and desire?

Answering these questions requires an understanding of how the poor obtain and use energy services both for consumption and productive purposes. It is thus imperative to have energy information on these issues. Traditionally, data collection and the dissemination of information on these issues were weak. According to Afrane-Okese (1995: 3), effective policy analysis requires a good data system within an established framework. In most cases data development needs to precede policy analysis by a large time margin. In practice, energy policymakers and planners have access to relatively little consistent, reliable data on the poor's current energy consumption or demand for improved services. This does not imply however that poor households are ill informed about the benefits of improved energy access or vague about their preferences and willingness to pay for improved services. It does however imply that those formulating policies and engaged in planning are poorly informed about the markets that people actually access and the services they prefer – thus they risk making interventions that are inconsistent with community needs and preferences.

The conventional method of energy information gathering entails the collection of data by means of surveys. Surveys could either be done telephonically, by post or like in rural and impoverished communities by, energy officers or practitioners. Local authorities and rural energy practitioners are mostly responsible for the dissemination of energy information. According to the World Energy Council (1999: 100) under conventional approaches substantial financial and human resource commitments would have to be made for the surveys necessary to capture the data, and for establishing information systems that could be accessed by the various agencies involved in rural energy development. For example, the cost for monitoring the government's off-grid solar concessions programme in the Eastern Cape, amongst 348 households in 2001, was about R100 000-00 excluding the data analysis

and report writing. The cost of the Urban Household Energy Usage survey, conducted amongst 780 households in Botswana in 2000/2001, was about R600 000-00, including data analysis and report writing (Afrane-Okese 2002).

The proposed methodology on the other hand, involving learners could be done cost-effectively as a learning area assignment. The information obtained can easily be updated once a year. In conventional surveys some respondents do not give true information or all the facts. The new methodology makes provision for the mitigation of this weakness. Offering learners marks for the information obtained and rigorously evaluating the quality of their responses in small groups could obviate this weakness of the conventional method (see chapter 5).

This chapter will firstly examine the value and use of household energy data and modelling. Secondly, it will evaluate the potential of the proposed methodology of household energy information gathering and dissemination through an integrated energy planning process that would enhance social equity, environmental sustainability, economic competitiveness and energy efficiency. This is done in the light of government policy objectives to stimulate economic growth, with the ultimate aim of eradicating poverty.

2.2 VALUE AND USE OF ENERGY DATA GATHERING AND DISSEMINATION

The United Kingdom's Secretary of State for International Development, Clare Short made the following statement: "Good statistics allied to appropriate government policies can change things radically and for the better. Development talk is full of statistics that are often old and unreliable and thus fail to capture the policies that produce progress or failure until it is much too late. Badly informed decisions particularly affect poor people." (World Bank Report 1999: 1). Without adequate energy statistics, the analysis of trends in the consumption, production and availability of primary and secondary energy resources is not possible. Reliable estimates cannot be made unless they are based on both current and historical data.

Consumers, who are armed with information and the freedom to choose, are a powerful agent for achieving economic efficiency through markets. A market economy functions well with a wide range of timely and detailed information on markets and on the economy at large. The availability of energy data will enable consumers to make informed decisions regarding the safe, healthy and environmentally sustainable use of energy. Access to information will assist community and local government leaders to proactively take up energy-related issues in society. According to Huggett and Blomkamp (1987: 2) energy

statistics can be used to analyse energy policy alternatives, particularly when viewed in conjunction with other statistics such as Gross Domestic Product, population and sectoral economic growth.

Effective policymaking needs a national energy modelling system to assist in the evaluation of the impacts of different policy options. Integrated energy planning principles rely heavily on understanding and interpreting the links between energy and the national economy, and modelling in an integrated energy planning system is the most appropriate tool for exploring these links (Doppegieter and Du Toit 1999: 23).

The poor use of energy models in the past was partly due to a lack of confidence in model parameters, which could largely be ascribed to a lack of availability and credibility of energy data. A lack of consistent data inhibits energy modelling considerably, which in turn seriously hampers energy policymaking and integrated energy planning.

Development and international donor agencies require good statistical data. According to Miguel Urutia of the Bank of Colombia, for instance, it was important for his country "to give foreign investors all the relevant data on the Colombian economy within a policy of transparency.... [as] it was believed that a lack of transparency and good data would discourage foreign investment and capital flows..." (World Bank 2000: 2). Good statistics thus ensure that a country is well placed to make the best case for itself in the international arena. They are crucial for firms considering investment in a country, and for international organizations making decisions on development programme.

Official statistics are essential in indicating those people and regions that are in greatest need, and thus the best use of scarce resources can be made in improving the living conditions of its inhabitants.

The dissemination of energy data is a crucial aspect of the statistical endeavour. Any national statistical body has a public duty to disseminate its output. It is funded from the public purse, so the public has a right to expect to see the fruits of its investment. The PARIS 21 (Partnership in Statistics for Development in the Twenty-First Century) report (2000: 1) states that a statistical system of integrity and transparency is a basic building block of a democratic society and that public access to its output is vital to the process. Ordinary citizens who contribute to supplying the data, from which the statistics are compiled, will be more cooperative in the data-gathering process if they can see how their contributions are used and valued – and perhaps even derive benefit from the statistics themselves. Giving society something back for its help in compiling official statistics is extremely important.

2.3 INTEGRATED ENERGY PLANNING

Eberhard and Van Horen (1995: 6) state that engineers have traditionally dominated discussion and analysis of the energy sector, which have been generally restricted to the technical aspects of supply. However, the cost of over-simplistic, large-scale energy supply investments has been significant, demand-side conservation measures have been overlooked, the environment has been ignored and access to energy services has not been equitable. After the end to cheap and predictable oil supplies in the 1970's, the focus in energy planning and policymaking began to shift from supply planning to an awareness of energy end-use, the potential of demand management and the necessity of integrated energy planning.

Munasinghe (1990: 2) defines integrated energy planning as a series of steps or procedures by which the myriad of interactions involved in the production and use of all forms of energy may be studied and understood within an explicit analytical framework.

Similarly, Eberhard and Van Horen (ibid: 11) define integrated energy planning as a detailed and comprehensive analysis of the energy sector, interactions between energy sub-sectors and the linkages with the rest of the economy. It also involves formulating and evaluating appropriate policies and implementing strategies to manage the demand and supply of energy to achieve desired objectives.

Loon (1996: 12) argues that an important additional source contributing to the theory of integrated energy planning is the International Energy Initiative (IEI). Led by Dr. Reddy, the IEI has designed an energy planning methodology entitled 'DEFENDUS'. The aim of the DEFENDUS (DEVELOPMENT-focussed, END-USE-oriented, SERVICE-directed) methodology is to 'defend us against' the various crises which face the energy sector in developing countries (Reddy 1994:14). It arose from unsustainable conventional approaches to energy planning – which regarded endless economic growth as being necessary for development. This methodology emphasizes the need for energy demands to be assessed and future scenarios formulated before supply-side options are considered. It is necessary to be aware of what is required at the end-use side of energy networks in order for energy suppliers to know what, how much and in what way to supply.

The analysis of energy supply options is fairly well established in most countries, but not end-use analysis. As Eberhard and Van Horen (1995: 11) put it: "Integrated energy planning, however, starts with the consumer." Thus, through disaggregated end-use analysis, major consumption sectors, such as households, commerce, industry, mining and agriculture, are defined.

Munasinghe (1990: 3) states that the rationale underlying all national planning and policy making is the need to ensure the best use of scarce resources, in order to further socio-

economic development efforts and improve the quality of life of citizens. Thus social equity, environmental sustainability and energy efficiency, which impact favourably on other development goals, should be the key objectives of a sustainable energy planning policy.

According to Loon (1996: 21) an adequately sized and suitably detailed energy database is indispensable for integrated energy planning and policy formulation. Economic, demographic, and other sociological information is required in addition to information about the demand and supply of energy. Without such information, planning will be *ad hoc*, inefficient or simply wrong. Moreover, cultural factors need to be investigated, such as gender roles, energy-related relationships between and within households and cultural beliefs that may inhibit (or enhance) the success of an energy intervention strategy. An energy database provides the energy planner with the invaluable knowledge of 'what is out there', in confirmation of the well-known adage, 'knowledge is power'.

Bhatia (1988: 63) argues that the development of a rural energy database at the national level is required for three reasons:

- (a) It places rural energy needs in the context of the overall energy demand of the country, underlining the significance of meeting the 'basic energy needs' of rural populations as well as the growing demands of rural agricultural, industrial and transport sectors;
- (b) The ecological impacts of conditions of energy use often have national or regional implications and require intervention at national or regional levels; and
- (c) A number of policy decisions affecting demand and supply of energy in rural areas are in fact taken at national or regional levels – for example, decisions regarding rural electrification in various regions, the allocation of funds for renewable energy sources, and the creation of pricing policies for electricity, liquid fuels, and coal, are taken at a centralized level but have significant implications for the decentralized rural population.

An important requirement of database development is that the flow of information should not be unidirectional, from energy consumer to planner. Rather, it should be participatory, as the dissemination aspect is equally important: people require information with regard to electrification and afforestation, for example. Generally, it is advisable to keep communities aware of what government assistance is available. Thus for integrated energy planning, database development is more a process of interactive communication than one of compilation of statistics.

For effective Integrated Energy Planning (IEP), energy information should cover critical issues like social equity, environmental sustainability, economic competitiveness and energy efficiency. This will ensure the necessary linkage of all the layers of information of the total economy required for effective planning.

2.3.1 Social Equity

As the South African government embraces widened democracy and is accepted in the international community, the need for social equity – specifically addressing the energy needs of the poor as part of its policy of reconstruction and development – has become more urgent.

According to Eberhard and Van Horen (1995: 37), the primary goal of the democratic South African government is to address the high levels of inequality, which characterizes both the energy sector and the economy as a whole.

Current patterns of energy consumption by South African households mirror the inequality, which characterizes the country's social and economic order. Many Black households, especially in rural areas, do not have access to grid electricity – and even those that do, make extensive use of multiple fuels because they cannot afford the cost of electricity use. The use of traditional fuels by low-income households does not only destroy the local environment, but causes adverse impacts on the health of people exposed to these effects. Moreover, poor households in electrified townships often pay higher electricity tariffs than consumers from historically white areas in which the grid and reticulation costs have since long been paid off.

The key equity issue is access to adequate and affordable supplies of energy. How does household energy information address inequality? Information and knowledge about household income levels, the types of fuels used, the race of the particular household, its geographical location, the type of households and gender-related issues, will greatly enhance policymaking and integrated energy planning. This kind of information will also strengthen the energy modelling process.

Such information gathered by learners will be geographically specific, obtained cost-effectively and could easily be up-dated from time to time. Moreover, engaging learners in the actual analysis of the information will not only raise their awareness of energy-related issues, inequalities and energy needs in their communities, but will also facilitate the dissemination of energy information in the home and the larger community.

2.3.2 Environmental Sustainability

Environmental quality has not been accorded a high priority in South Africa. Air pollution has local, regional and global implications.

It is especially at the household level, where the most inefficient use is made of coal, biomass and paraffin, that the most serious environmental impact is experienced. Indoor air-pollution resulting from the use of these fuels causes respiratory, eyesight and other health problems.

Other environmental problems experienced by the household sector include incidents of trauma and even death due to paraffin poisoning, and burns and fires resulting from accidents with candles and other fuels. In addition, in urban and peri-urban townships the outside environments are degraded by the combustion of traditional fuels, especially wood.

At the regional level, especially in and around the cities, the use of fossil fuels, especially oil and coal products in transport and electricity generation, produces attendant health problems related to respiration. At national and global level, oxides of sulphur and nitrogen emissions affect local environments by causing acidification, which in turn leads to the deterioration of soil, vegetation and water supplies.

Most of the ESKOM power stations are coal-fired, which causes a lot of damage to the environment in terms of carbon dioxide emissions. South Africa is an energy intensive country and its economy is largely based on the combustion of coal. Renewable sources of energy (such as solar, hydro-electric, wind) on the other hand contribute insignificant amounts to the total energy needs of the country, especially if biomass is excluded.

A major shift towards cleaner and sustainable sources of energy should be encouraged in the future (Eberhard and Van Horen 1995: 38). However, the environmental challenge is not only to reduce pollution, and to move from non-renewable to renewable resources. Rather, it is also a challenge of equity. No solution will work if there is not greater equity in terms of access to resources.

The household energy sector in rural areas is dominated by the use of biomass fuels. These fuels are gathered freely in many places, but are also threatened by agriculture in the competition for land. Extensive biomass use could also lead to deforestation. It is mainly women and children who are engaged in the arduous and time-consuming task of gathering fuelwood for cooking and heating. These practices furthermore perpetuate gender inequality.

Eberhard and Van Horen reported in 1995 (36) that the concept of sustainable development in South Africa had only recently received some attention from the research and academic community, but had so far not informed national energy policy making in any substantial way. Although some progress has been made since then, the concerns embodied in the sustainable development paradigm need to be addressed in the coming decade. The question is: will these concerns be addressed in systematic, well-planned ways or in an *ad-hoc* manner as the need arises?

Household energy information on the types of appliances people use, disaggregated fuel end-usage, fuel prices, dwelling types, and thermal performance and insulation levels is necessary in order to address the question of environmental sustainability.

The regular gathering of information on fuelwood usage in a particular geographical area could be more up-to-date than information collected every 3 to 5 years over a short period of time. Learners in a specific locality are more acquainted than outside energy data collectors with their environment and patterns of fuel usage. Through a process of energy education, learners become more aware of the dangers of deforestation, paraffin poisoning, candle fires and can convey this knowledge to the community (see energy education chapter 5). Raising learners' awareness of the prudent use of our natural resources through a process of energy education can thus contribute to the development of a sustainable environment.

2.3.3 Economic Competitiveness

Energy is needed by most economic sectors, for instance commerce and industry. It is pervasive and cuts across almost the entire economy. Eberhard and Van Horen (1995: 3) state that improved social equity is an important condition for sustained economic development. Sustained economic growth is dependent on the development of an internationally competitive productive sector, which is incompatible with high levels of inequity. Achieving economic competitiveness requires an investment in the creation of a better-skilled, better-educated and better-paid workforce.

In order to achieve greater equity and economic efficiency, household energy data on the cost of fuels, cost of appliances and equipment, and the availability of credit, are essential elements to effect rational energy policymaking and planning. By means of energy modelling, the economic competitiveness of the various policy options could be assessed. Estimates of current trends and future projections could also be established. All of these require reliable data.

Learners, who are appropriately trained and thus equipped with the skills to collect and interpret energy data, can use these skills to gather economic data about their communities, which in turn could be utilized to assist with economic development and education.

For our economy to compete internationally, it is essential to train and educate our learners about energy-related issues. The ability of our country to confront its energy challenges depends as much on the successful development of our human resources as it depends on the wise use of our natural resources.

2.3.4 Energy Efficiency

A sustainable system delivers services without compromising and exhausting resources. It uses all its available resources efficiently, both in an economic and an environmental sense. A key priority in moving to a more sustainable energy system is the application of a policy of energy efficiency.

According to a World Bank report (2000: 6), there are almost always technical alternatives to existing energy systems, which can come into play when looking for solutions to problems caused by conventional energy systems. This may be desired in the following cases, for example:

- When an energy system causes unacceptable pollution levels (e.g. by contributing to local air pollution, acid rain or climate change);
- When the energy system destroys renewable resources (e.g. deforestation);
- When the energy system consumes too much time (e.g. fetching wood); and
- When the available resources are inadequate for enhancing the supply of energy services to more people.

Energy efficiency is an approach, which enhances the output per unit of production of the energy system in such a way that either (a) the same energy output can be generated from less primary energy source or fuel, or that (b) the same amount of fuel can generate more energy. Goldemberg *et al* (1994: 33) states that efficiency improvements require a favourable policy environment. How far energy efficiency measurements should be pursued must be evaluated from the dual standpoint of socio-economic development and protection of the environment. However, energy efficiency must be the core of a genuine strategy for sustainable development.

Energy efficiency should be an integral characteristic of any product, activity or planning process. Policy formulation should start from this observation, and focus on making energy performance an intrinsic part of the continuous on-going investment process.

According to Reddy (1991: 95) a number of barriers face actors in the selection and implementation of a least-cost solution from a societal perspective. These are: the initial costs to poor people are prohibitively high; energy prices are much less than the full costs of energy (externalities), with the result that some consumers pay little attention to energy, because it is not a significant expense and the beneficiaries are not the same as the ones that incur the investments (e.g., the landlord/tenant problem).

Monopoly utilities in many developing countries, especially from the supply side, have no or few incentives to apply energy efficiency measures, because there is hardly any competition and no properly functional regulatory framework.

A one-dimensional energy efficiency policy will do little to influence the millions of everyday decisions affecting energy use. An effective energy efficient policy must be well integrated with the overall aims of other policies, e.g. to improve people's welfare in employment, housing and transport. In other words, energy efficiency policy and other policies should mutually reinforce each other.

Energy efficiency should be at the forefront of energy planning and policy formulation. On a very practical level, this should involve the construction of thermally efficient dwellings, the promotion of energy efficient appliances, appliance labelling, and the implementation of time-of-use electricity tariffs.

An International Energy Agency report (2000: 13) on energy efficiency stresses the need for continuity in energy planning and policies. Realising the potential for the economic and environmental gains that can be achieved through energy efficiency requires a clear policy approach that is persistent and carries a consistent message. It demands careful evaluation and monitoring to adapt policies and measures to changes in consumer demands, technology progress and other dynamic parameters. Furthermore, it needs an energy efficiency ethic that functions with the grain of the market and it needs to strengthen harmonization efforts to join market forces to enhance dissemination and bolster international co-operation.

It is important to make use of the existing knowledge and past experiences with energy efficiency programmes of countries around the world, and incorporate local aspects in order to develop effective models for energy efficiency projects that fit within the local knowledge systems and organizational structures.

Learners who are armed with the knowledge to understand and contextualise the effects of the production and use of energy on our environment, society and economy will more likely practice and encourage a culture of energy efficiency as opposed to those who are not "energy literate". Energy education is the ideal medium to disseminate knowledge to learners and communities with regard to methods to save energy both at school and at home. This can result in energy savings and subsequently reduce the cost of energy.

Household energy information collected by learners also provides an educational opportunity to graphically represent, compare and debate the information and to seek ways of becoming more energy efficient.

2.4 CONCLUSION

This chapter has argued that reliable and up-to-date energy information is crucial to the formulation of effective energy policies, integrated energy planning and energy modelling, in order to effect sustainable and healthy development.

An integrated energy planning process is a *sine qua non* to improve poor people's access to affordable and reliable energy services. This process contributes to the universal priorities of social equity, environmental sustainability, economic competitiveness and energy efficiency and can be enhanced through engaging learners in the gathering and dissemination of household energy information.

Learners are ideally suited to gather energy information especially on the use of fuelwood, the main source of energy to the rural poor. They are familiar with the environment, patterns of energy use, and can regularly, at no cost, update energy information. Through this engagement learners also benefit educationally by integrating the gathering and dissemination of energy information with other learning areas. Learners are an excellent source for the dissemination of information to their households and the broader community. Furthermore, in this way learners' knowledge, values and attitudes by effectively engaging with local, national and global development issues, is greatly enhanced.

3. ENERGY EDUCATION IN INDUSTRIALISED AND LESS DEVELOPED COUNTRIES: A COMPARATIVE OVERVIEW

3.1 INTRODUCTION

The energy crisis of the 1970's and the rapid increase in information, globalisation and the extent of specialization in our understanding of the world, has over the last decade of the previous century led to different dimensions of education, which impact to a greater or lesser degree on the education system of which they are a part.

Energy education is one such dimension of the broader educational system, which seeks to provide educational programmes and materials on energy-related topics, technologies, fuels and the impact of energy use on the environment, and to understand the context in which energy issues can be evaluated.

In many countries, and particularly in industrialised nations, the educational sector has become the focus of considerable attention by governments and developmental agencies for the following reasons:

- Educating learners about all aspects of a particular energy source – its availability and its monetary, environmental and social costs – will help them to make informed decisions about energy at home and in future at work;
- Educating the public in general about the economic and environmental costs of energy use is one of the best ways of helping to curb energy waste;
- An energy-literate public is needed to make well-reasoned decisions about energy options and to use our natural resources more wisely – which is the key to sustainable development;
- Energy education plays an important role in the dissemination of energy information. Industrialised countries, where energy education is an integral part of the school curriculum and where the general public is well informed about such matters, have made far greater progress in the development and implementation of energy education than Less Developed Countries (LDCs), which will be discussed in section 3.2

This chapter seeks to assess and compare the different levels of energy education in Industrialised Countries (the U.S.A., Canada, Italy and the United Kingdom) on the one hand

and in Less Developed Countries (Ghana, India and Thailand) on the other hand, and the role-played by learners in the gathering and dissemination of energy information.

3.2 INDUSTRIALISED COUNTRIES

3.2.1 United States of America (USA)

The United States of America (USA) has one of the most comprehensive and advanced curricula provisions for energy education. Some of these programmes are NEED and Alliance to Save Energy.

The NEED project

The National Energy Education Development (NEED) programme, a service of the Department of Energy (DOE), in collaboration with education departments, is responsible for coordinating energy education in the USA.

The mission of NEED is to promote an energy-conscious and educated society by creating effective networks of learners, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programmes (NEED 2001: 1).

NEED is dedicated to developing and distributing comprehensive, hands-on energy education programmes to schools nationwide. Learners are presented with scientific explanations of the role of energy in society. Curriculum materials and activities are designed to promote an understanding of the economic and environmental trade-offs of energy, so that learners will be able to make educated decisions in the future (ibid: 1). Energy education is incorporated into the syllabi of most subjects, so that it is not only taught to mathematics and science learners.

The NEED programme includes up-to-date educational materials, evaluation and recognition of achievement, as well as professional development and training for educators. It also encourages the development of critical thinking skills and for learners to consider the trade-offs inherent in energy use. Furthermore, these materials are available for all grade levels, from kindergarten through high school.

Since its inception in 1980 the NEED programme has recognized that teachers are vital to the success of the programme. Training is offered at local, state, regional and national levels. Teachers attending workshops and conferences earn professional development and academic credits. Energy professionals provide day-to-day guidance and support to teachers and in collaboration with them create new NEED programmes.

The evaluation of NEED programmes by both teachers and learners is an important component of the success of NEED. Programmes are also regularly updated and reviewed.

Alliance To Save Energy

“[The] Green Schools [project] is a win-win for schools—not only do kids help save energy in their schools, but the hands-on experience greatly strengthens the maths and science learning that will be so important to our country’s future” (Richardson 2001: 1).

The Alliance To Save Energy is a non-governmental organisation founded in 1977 by concerned decision makers and opinion leaders as a direct response to the oil embargo of the 1970’s. Its key aim is to promote a national and international commitment to energy efficiency and sustainable future.

The Green Schools (2001:1) programme is a comprehensive educational initiative of the Alliance to:

- Combine conservation and education in a way that strengthens both;
- Involve learners in making a real difference to the way that energy is used at schools;
- Encourage teamwork and energy awareness to create a healthy planet for future generations;
- Foster community involvement.

The programme gives learners a ‘real world’ picture that reinforces curriculum content with lifelong energy-saving practices. Green Schools save energy costs in two ways:

- Through behaviour changes and building retrofits schools save energy by making simple changes in building operations and maintenance;
- By saving water and electricity and reducing waste.

3.2.2 Other Industrialised Countries

Other industrialised countries where energy education has been taken seriously are Canada, Italy and the United Kingdom.

Statistics Canada actively supports energy education by developing and offering easy access to a wide variety of statistical products and services that have been designed specifically for learners and teachers (Statistics Canada 2000: 1).

In Italy Census 2001 was preceded by the ‘*Censimento a scuola*’ (Census in Schools). This stimulated all phases of the census, from data collection to their release (2001: 1). A similar pre-census exercise was launched in the United Kingdom and in New Zealand. Making school children familiar with statistics does not only encourage them to be good respondents in the future, but it is also argued that those who know how to interpret statistics make better citizens (Census Italy 2001: 1).

In the United Kingdom, according to Sinclair (2001: 3-4), the recently published document, 'Developing a Global Dimension in the School Curriculum', is the first to offer official curriculum guidance in this area. The document highlights sustainable development, human rights, global interdependence and issues pertaining to environmental degradation. The document gives examples, which show how its inclusion in the curriculum builds knowledge and understanding, as well as developing key skills and attitudes. This is backed-up by a new website on the National Grid for Learning which provides a United Kingdom-wide database of resources as sources of support.

3.3 LESS DEVELOPED COUNTRIES

3.3.1 Ghana

The Alliance to Save Energy's Green Schools International project is working extensively in Ghana and India to develop energy efficiency and environmental education. Ghana has enthusiastically embraced the Green Schools programme since the late 1990s. The Energy Foundation of Ghana, working with the Ministry of Education and the Green Schools programme formed the Energy and Environmental Clubs (EECO). Using the Green Schools' hand-on activities, they teach children about the role of energy in their lives and the connection between energy and the environment. Most schools in Ghana use little energy (most are not electrified) thus there is a greater focus on ways to reduce energy usage at home.

The aim is to expand the programme and make it part of the national curriculum for both primary and high schools.

3.3.2 India

The Alliance (2001: 1) has also worked with India's Centre for Environmental Education (CEE) to develop energy efficiency programmes in schools. The CEE is a well-established network and the Alliance recognized the opportunity to integrate India's environmental and energy concerns into a comprehensive educational strategy.

The CEE and the Alliance offer after-school voluntary workshops to teachers in energy issues and train them to start Eco-clubs in their schools. As in Ghana, school energy usage is low, thus the emphasis is on residential energy usage. For example, in 2000 learners analysed home energy usage, identified strategies for conserving energy and actually achieved up to 15% savings on their families' energy costs (ibid: 5).

The Alliance sponsored an end-of-year celebration from 4th to 6th March 2000 in Ahmedabad for Eco-club members and their teachers. The celebration offered learners the opportunity to understand the need for energy and water conservation and helped them to

internalise those concepts in an effective and enjoyable forum (games, competitions and quiz).

3.3.3 Thailand

In Thailand, the Dawn Project was launched with the aim of assisting learners and teachers to understand and appreciate the importance of energy and the environment, thus ensuring that the youth have knowledge, skills and opinions about natural resources and environment problem-solving, as well as how to prevent these problems from occurring in the future (Thai-Danish Cooperation on Sustainable Energy 1999).

The project was launched by three agencies: The Ministry of Education, which was responsible for its implementation, the Office of the National Power Committee, which provided funding and data, and energy resource persons and experts, who provided the scientific background and documentation.

In addition, the governmental departments of Environmental and Quality Promotion and Energy Development Promotion offered courses concurrently to promote teacher competence with regard to environmental and energy-related issues.

Two challenges emerged with regard to these initiatives and projects in Thailand:

- There is a lack of coordination of activities, in that the various agencies do not know what others are doing in the same field; and
- Secondary school learners are not particularly interested in energy and environmental issues. Possible reasons could be that there is little or no academic reward for learners who do participate in these programmes. Moreover, energy and environment studies are not one of the subjects given importance during the competitive examination to gain entry to institutions of higher learning. Lastly, a lack of teacher support and professional assistance may also lead to poor presentation of projects.

3.4 CONCLUSION

As can be seen from the above brief discussion, the provision of energy education and fostering a statistical culture are more comprehensive and well established in Industrialised Countries than in the Less Developed Countries, primarily because the former have better resources, infrastructure and capacity.

It is also clear from the experiences in both Industrialised and Less Developed Countries that sustaining an energy educational programme requires a national educational initiative, which is supported by energy agencies and experts. Learners also need to be rewarded

academically to sustain their commitment and enthusiasm for the programme. The energy and environment programme of Thailand clearly demonstrates this.

In the USA, for instance, teachers are professionally rewarded for their participation in the programmes. Ongoing teacher training in energy-related issues, supported by professional bodies in the field, is of paramount importance to the sustainability of the programme.

Energy and statistical education, as taught in both Industrialised and Less Developed Countries, focuses mainly on creating a statistical culture and promoting energy awareness among learners.

Thus the learners, who are involved in hands-on information gathering and interpretation, are by virtue of the process also mediums for the dissemination and application of energy conservation strategies or policies or approaches. They furthermore benefit by internalising energy concepts and integrating them into their daily lives, and hence are better equipped to make rational and informed choices about suitable energy use strategies. Lastly, hands-on involvement of learners in research projects equips them with valuable research skills.

To conclude, the research of the above Industrialised and Less Developed Countries shows that they focus on one of the two underlying components of the methodology proposed, namely to educate learners about energy-related issues and the environment. The information collected is thus not used for the development of a national household energy database or to inform energy policymakers and planners. This thesis hopes to demonstrate that learners' engagement in the process should not be limited to energy education only, but that their involvement has the potential to supply valuable energy information required by policymakers and energy planners.

4. OVERVIEW OF CURRENT HOUSEHOLD ENERGY INFORMATION AND THE LEVEL OF ENERGY EDUCATION IN SOUTH AFRICA

4.1 INTRODUCTION

Energy is an important factor in developmental processes and in fact constitutes the basis of our livelihood. South Africa, given its historical past, urgently needs past and current energy information to formulate energy policies and planning strategies to redress past imbalances and create sustainable development.

This chapter examines the current energy data gathering and dissemination process in South Africa and discusses the present level of energy education in schools across the country.

4.2 PRE-DEMOCRATIC SOUTH AFRICA

The pre-democratic South African government severely restricted energy-related information and statistics. The Petroleum Products Act (No. 120 of 1977) prohibited the publication or dissemination of information on the source, manufacture, consumption or stock level of oil products produced or acquired by South Africa. The reason for this was political, in that petroleum products had a high strategic priority as a result of the country's international isolation. Moreover, before the unbanning of the African National Congress and other anti-apartheid movements in 1990, not much collection of household energy data for Black households had been undertaken in an organised form.

The first attempt at compiling a comprehensive set of official government data on the energy sector during the apartheid era was the document called "Energy Statistics No.1", published in 1989. It however excluded all information on liquid fuels, including for example, the amount of coal used to manufacture liquid fuels (IEA 1996: 69).

"Energy Statistics No.2" included liquid fuels, but excluded important factors such as the quantities of imports and exports of refined produce (ibid: 69). This document, which was published at the end of 1995, contained information only up until 1993.

The main reason for these omissions was that the information collected during this period was only that which was supplied by the large energy-providers. To them the energy information was largely secretive because of its market and strategic value.

In 1992, the then Department of Minerals and Energy Affairs (DMEA) gave funding to the Energy for Development Research Centre (EDRC), which was to establish a National Domestic Energy Use Database (NDEUD) system. With regard to this, Afrane-Okese (1995: 3) reports that the NDEUD project was a first step in the process of incorporating demand-side data and integrated energy planning into policy and implementation programmes for improving the situation in the household sector. This database system attempts to provide a comprehensive collection of information on low-income households' energy usage. The system comprises a number of databases relevant to integrated energy planning for low-income households and a user-friendly computerised system, which integrates the various components. It also contains related socio-economic, demographic, housing and geographic data. This system allows for the identification of research and information that may be relevant to policy analysis and further allows for information to be added and edited.

Some of the weaknesses of this database are the following: gender issues were not seriously explored and developed; data was collected in an *ad hoc* manner and in some cases resulted in the duplication of data; different methodologies were employed in data collection at different times and different places.

Prior to the democratic elections of 1994, various attempts were made to establish a national energy modelling system in South Africa. A system forecasting the long-term energy requirements of the country, using econometric techniques proved to be inadequate after the oil crises of the 1970's. The CSIR (Council for Scientific and Industrial Research) was also engaged in energy modelling initiatives. These modelling initiatives however focused primarily on the energy needs of and policy planning for commerce and industry. As a result of a lack of government support, funding and consensus amongst scientist concerning an ideal model for South Africa, the various attempts to establish a national energy model were never successful.

According to Eberhard and Marquard (2000: 5) attempts to set up rational planning in the energy sector by bureaucrats failed, and in fact the whole apartheid edifice was so fundamentally irrational in its inability to express any realistic energy demand pattern, that the introduction of democracy was a prerequisite for the development of a more rational energy system. It was thus impossible from any point of view – social, environmental, or economic – to meet the goal (now commonly accepted) of sustainable development under the old paradigm.

4.3 DEMOCRATIC SOUTH AFRICA

The shift to a new paradigm happened in a real sense from the 1980s. The process can be understood in three aspects, namely: (a) the intellectual development which began in the 1980s with a number of researchers who had developed an interest in the energy problems of low-income households (b) the political aspect began with the unbanning of the African National Congress (ANC) in 1990. A productive relationship developed between researchers and ANC activists around policy processes that surrounded the negotiations preceding the 1994 elections and (c) in terms of structural change the shift has been far more problematic. The policy processes leading up to the 1998 White Paper produced only one significant shift in the allocation of resources, namely the national electrification programme (ibid: 5).

The Department of Minerals and Energy (DME) is the government body with the most direct interest in high quality energy information, and it is aware of the serious shortcomings of the present system.

In 1995 the DME tendered a three-year contract to the Institute for Energy Studies (IES) at Rand Afrikaans University (RAU) to survey consumers to obtain information on the application of energy use (thermal, mechanical, etc.).

The aim was to ensure that data is available to support policy development and to meet the country's formal reporting obligations to regional and international organizations (IEA 1996: 71). A factor, which inhibited the RAU/IES in developing an accurate and comprehensive energy database for South Africa was the fact that neither it nor the DME had a legal right to oblige commerce and industry to supply energy data. This meant that in certain areas data was very poor or incomplete.

Afrane-Okese (1995) in a report for Technology Research and Investigations (TRI) attempted to compile the most comprehensive report on domestic energy use analysis in South Africa. This report provided a more in-depth analysis and projections of energy use in lower-income households, which in turn provides more accurate data for policymaking and planning, than had previously been the case. It also attempted to incorporate end-uses of the different categories of low-income households to estimate energy demand projections based on scenario modelling. Despite the value of this report, the DME has not managed to build on the findings and recommendations contained in the report.

The present system of energy data collection is a mix of private and public information gathering and dissemination. Eskom, the national utility undertakes very useful national surveys, but they have always had a business focus.

Recently, in-depth qualitative energy information on low-income households has been gathered through the DME funded Social Determinants of energy use in low-income households (Mehlwana and Qase 1996).

Energy data collection and dissemination for commerce and industry is done in a more consistent manner. The October Household Survey, which is conducted annually by Statistics South Africa, gathers and disseminates information on households, but not to the level of detail and aggregation required for energy policy making. Data on biomass used by poor households also does not form part of this survey, and it moreover lacks analysis of household fuel-use patterns.

Currently, the DME is funding a project on a national energy database, which is being conducted by Dr. Pouris from Science Consultancy Enterprises. This project seeks to gather energy data on the supply and consumption of all energy carriers, with the exception of fuelwood, which is very much a non-commercial fuel, whose supply cannot be easily quantified. According to Tony Golding from the Energy Directorate of the Department of Minerals and Energy, this kind of data collection is not very disaggregated when it comes to the residential sector. He further contends that since 1997 the DME has ceased to fund projects on household energy surveys (Golding 2000).

4.4 ENERGY EDUCATION

One of the underlying philosophies of our new education system (Outcomes Based Education: Curriculum 2005) is to engage and support learners in collecting, analysing, organizing and critically evaluating information. Engaging learners in research methodology is in line with the spirit of Outcomes Based Education.

According to Jenny Rault-Smith (2001), Chief Curriculum Planner, Western Cape Education Department, national and regional education departments have no policy or curricula to promote the teaching of energy education. She is of the opinion that topics related to energy education will be infused in the different learning areas, but that energy education per se will not be offered in the near future because of competing priorities. The Revised Curriculum 2005 plan places special emphasis on community-based research projects for schools for which learners will receive academic credit.

However, the extent to which energy and statistical education will ultimately feature in these projects will depend largely on teachers' knowledge and understanding of energy and statistical education.

The White Paper on Energy (DME 1998: 110) states that South African energy consumers, from low-income households to business and industry, are poorly informed about good

energy-use practices and options. This lack of consumer knowledge about the effective use of energy undermines economic competitiveness, the sustainability of development initiatives, the environment and people's health. Education and access to information can play a central role in addressing these problems, which is borne out by international experience.

The department therefore envisages the following two strategies:

- To facilitate the flow of information between users, suppliers and government; and
- To integrate information awareness programmes with other government departments, for example, health and education.

These stated intentions by the DME are an acknowledgement of the importance of energy data gathering and dissemination to achieve government objectives of economic efficiency, social equity and environmental sustainability. The DME has not yet managed to give substance to its stated strategies to promote energy information gathering and dissemination with the Department of Education.

The Department of Environmental Affairs and Tourism on the other hand is actively encouraging environmental awareness programmes at schools. Regional and national environmental quizzes have become annual school events. However, questions asked at these quizzes very seldom focus on energy-related issues specifically.

The Department of Water and Forestry has launched the 'Work for Water' projects in various schools throughout the country to promote an awareness of water conservation. According to a report released by the Water Research Commission, researchers from the Centre for Scientific and Industrial Research (CSIR), Hazelton and Harris (2000: 20-21), developed a methodology for involving communities in collecting data on water and sanitation. The aim was to develop a pilot database on the provision of water and sanitation in various communities in a sub-region of the Northern Province, which could be replicated countrywide.

Part of the methodology followed by Hazelton and Harris was to establish what the existing situation was, both locally and internationally and to develop data collection procedures emphasizing contributions at a local level. The main results from this report stated that data collection at village and community level has assisted communities to become more involved in their own development. Further, by providing additional information on conditions in similar villages, the research has assisted each village to become more aware of other development initiatives in the country (ibid: 21).

In a paper delivered at the Centre for Advancement of Science and Mathematics Education, professor George Ellis (1999) of the Department of Mathematics, University of Cape Town,

suggested that the mathematics curriculum in South Africa be arranged in two courses: mathematics for everyday life and mathematical theory and practice. Both should have a large component of practical projects relating to daily living. He further contends that we should not only be talking about projects for the sake of education, but about projects that make a real contribution to significant research programmes.

Ellis further contends that census data gathering as a continuing school project offers the possibility of having much of the required census information available on an up-to-date basis. This will also raise the awareness of learners about the challenges faced by their communities, and they could even be encouraged to develop their own unique solutions themselves.

According to Burnett (1999: 5), matric learners throughout the Wild Coast region of the Eastern Cape conducted a mapping project of all economic activity in their areas for the first time in 1999. The project is believed to have collected the area's most comprehensive economic data ever. A project of this nature has the potential to provide a resource for communities wanting to start their own income-generating activities, whilst also providing valuable economic data to potential investors.

4.5 CONCLUSION

Sustainable development strategies in South Africa face significant obstacles, some of which concern the issue of household energy data collection and dissemination. South Africa has no up-to-date, comprehensive and structured household energy database, which could be used by policymakers and planners.

The DME expresses the intention and acknowledges the importance of energy awareness programmes in collaboration with the Department of Education, but has not managed to initiate these.

On the other hand, projects and programmes by the Departments of Environmental Affairs and Tourism, Water Affairs and Forestry, have been more successful in engaging learners and communities in awareness campaigns and data gathering.

The economic mapping project carried out by matriculants (discussed above in section 4.4) demonstrates that learners can play an important role in gathering data and the hands-on approach has raised their awareness about community challenges and possible solutions.

The absence of energy and statistical education, coupled with a lack of energy information, is a sufficient condition for unsustainability and community underdevelopment.

However, under our new education system (Curriculum 2005), which actively promotes and encourages research and community-based educational activities, energy and statistical education are more likely to become more significant.

University of Cape Town

5. AN EVALUATION AND ANALYSIS OF THE APPLICATION OF THE METHODOLOGY

5.1 INTRODUCTION

This chapter seeks to assess the validity of the hypothesis that the methodology described in Chapter One has the potential to achieve the aforementioned objectives.

To analyse and evaluate the objectives of the methodology, both qualitative and quantitative research methods were applied over a period of about seven months (late April to early December 2001) to Grade 10, 11 and 12 learners from Ocean View High School in Cape Town.

The Ocean View community is situated approximately twenty-five kilometres from central Cape Town along the False Bay coast. It is a historically disadvantaged Coloured community, with one high school and has a student population of approximately 1135 and a staff complement of 33 teachers. Twenty five percent of the student population is Black and the majority of them live in an informal settlement, Masimaphumelele, about four kilometres from Ocean View.

As a first step, an energy education programme was introduced. The key objectives of this programme were to see to the extent to which a greater awareness of energy-related issues would impact on learners' behaviour, contribute to their educational development and ultimately engage them in household energy data gathering and dissemination.

The programme was comprised of the following activities:

- Prior to implementing an energy education programme, both teachers and learners were engaged in discussions pertaining to energy-related issues and were subsequently made to complete questionnaires in order to ascertain their current knowledge and understanding of these issues;
- A project and debate on climate change;
- The formation of an energy patrol group;
- Graphical representation and interpretation of energy data collected.

As a second step, learners were engaged in gathering information about household energy usage. The aim was to evaluate whether this process was more cost-effective than conventional surveys, and whether it would render up-to-date and usable energy information

that would be valuable to energy planners and policymakers. Lastly, by interpreting the information and debating the issues that arose during the course of the programme, people would be encouraged to seek solutions to some of the challenges themselves.

5.2 ENERGY EDUCATION PROGRAMME

5.2.1 Preliminary Discussions and Informal Interviews on Energy Education

Preliminary stimulating discussions were held with learners and teachers on energy use and education. The aim was to assess their general knowledge, insight and understanding of energy related issues. Subsequently a questionnaire was developed for both learners and teachers.

The questionnaire focused on energy conservation, energy efficiency, and primary energy usage in South Africa and what this energy usage pattern meant for present and future South African society. It also looked at renewable and non-renewable sources of energy, as well as at problems associated with the use of particular fuels (paraffin, gas, candles, fuelwood and dung, car batteries, dry cells, petrol and diesel). Furthermore, teachers were asked to comment on the need to include energy education in the school curriculum, the potential challenges to integrating energy education into the school curriculum, and the likely impact which a greater awareness and knowledge of energy matters would have on teachers, learners and society in general (see Appendix 1 for the actual questionnaire used).

Broadly speaking, the results of the questionnaire revealed the following: Both teachers and learners perceived energy as the ability to do work and their definitions bothered on potential and kinetic energy. This result was not surprising, as this is how energy was defined in school science textbooks. This narrow scientific view of energy however led learners to the idea that energy was somehow removed from our lives. Both teachers and learners had little knowledge of energy conservation, energy efficiency, the effect of energy on the environment, and issues pertaining to the sustainable use of our natural resources.

Teachers' View about Energy Education

All teachers enthusiastically supported the teaching of energy education in our schools. They expressed the view that there was a need to integrate energy studies into the existing curriculum. As one teacher put it: " children could in fact be the best medium for disseminating energy information and awareness, as they were able to convey this knowledge to their peers and elders. Learners would be able to apply this information in their future lives and eventually pass it on to future generations. Raising the awareness of learners would furthermore broaden the debate about energy-related issues, and in this way possible solutions to energy problems could be found".

The teachers believed that for South Africa to compete globally, learners needed to debate, research and talk about energy in order to make scientifically informed decisions in their lives. They expressed the belief that energy education should not be confined to mathematics and the sciences, but should be implemented in a cross-curricular fashion, thus enabling all learners (including those who do not study mathematics and science) to be educated about energy, as it ultimately affects everyone.

Teachers, being ultimately responsible for the facilitation and implementation of energy education, were however very conscious of possible impediments or obstacles relating to an energy education programme. Their main concerns were:

- The lack of finance and resources;
- The willingness of teachers to cooperate stemming from a lack of awareness and knowledge concerning energy and the environment; and
- Education authorities not driving the process.

They were of the opinion that a greater awareness and knowledge about energy would have the following advantages:

- It would encourage learners to seek careers in the field, thereby increasing the pool of knowledge;
- It would generally enhance people's understanding around issues pertaining to energy conservation and the sustainable and efficient use of energy;
- Learners and communities would be better equipped to deal more effectively with challenges and problems.

Learners' Responses

The learners' responses highlighted two main issues:

Firstly, very few learners were aware of or understood the difference between renewable and non-renewable energy sources. From questionnaire responses and a follow-up discussion it became clear that the learners from the informal settlement had a better understanding of the context of traditional fuel usage and the concomitant dangers involved in its usage, as opposed to those learners not living in an informal settlement.

Secondly, in terms of the meaning of those energy concepts and a follow up discussion about the issues concerned, the majority of learners saw energy conservation, energy education and the effective use of renewable energy resources as possible solutions to our dependence on fossil fuels.

5.2.2 Project on Climate Change

“The release of greenhouse gases through human activities is creating a thick blanket in the atmosphere. Carbon dioxide resulting from the burning of fossil fuel is the largest single source of greenhouse gas emissions. Concentrations of this and other greenhouse gases (GHGs) will continue to increase global warming. Physical impacts such as rising sea levels will dramatically alter the natural balance of local and global ecosystems, flooding low-lying delta areas, increasing salt-water intrusion, and intruding into human settlements. From a human security perspective, poor and vulnerable people will be most affected by climate change.” (Denton 2000: 13).

Discussion around the above definition of climate change, supplemented by readings of a newspaper clipping entitled ‘Companies must buckle up for climate change’ (Visser 2000) and an article at the Pew Centre homepage, entitled ‘Getting it Right: Climate Change Problem Demands – Thoughtful Solutions’ (Claussen 2000) formed the basis to introduce learners to the topic.

Twenty-three grade 12 learners taking mathematics as a subject took part in the project. This project on climate change was chosen firstly because it involved household energy information gathering and because their findings were important to raise their awareness about their families’ contribution (in a small but nevertheless significant degree) to the greenhouse effect. Secondly, the project taught and tested skills in mathematics and physical science. The project also served as a formative component counting towards their year mark.

Firstly, they were asked to keep an energy diary for just one day in order to calculate the amount of carbon dioxide they put into the environment each day by their use of electricity. Secondly, and in response to their findings, they drew up an “energy diet plan” for the entire household in order to calculate the amount of carbon dioxide emissions saved by their household members (see appendices II and III). Anticipating that not all household members would cooperate, a role-play session was held in the classroom to empower learners to illicit the cooperation of all household members.

After completing the assignment, the learners were asked if the project had in any way altered their behaviour and or the behaviour of members of their household with respect to the usage of electricity. A lively discussion ensued and they indicated that the project did indeed impact positively on their own behaviour, as well as on the behaviour of some of the members of their respective households. All agreed that the presentation skills developed and practised in the classroom prior to asking for the cooperation of their household members had greatly assisted them in convincing household members about the merits of the assignment.

It was from this discussion that the idea was borne to start an energy patrol group at the school, called "Watt Watchers".

5.2.3 Watt Watchers – Energy Patrol Group

In late July 2001 a submission was made to the School Governing Body (SGB) of Ocean View High School to start an energy patrol group at the school. The SGB approved the idea and even financed the purchase of T-shirts with the slogan: "Watt Watchers – Energy Patrol". A group of seven learners, which made up this group, was introduced at a school assembly and their role was explained to the student body and staff (see appendix IV).

Significantly, shortly after the formation of this group, the Western Cape Education Department (WCED) conducted a general audit at the school, and they were impressed with the various cost saving measures that the school had implemented.

The Main Objectives

- To reduce school energy usage and utility bills (electricity);
- To increase learners' knowledge and understanding of energy usage and how it affected the school budget and the environment;
- To sensitise other learners about issues pertaining to the importance of energy conservation/efficiency;
- Through their participation they would be encouraged to apply what they had learnt at home and also to teach others in their community.

Implementation

Learners implemented, monitored and evaluated the process to see what energy savings were in fact realized:

(a) Through behaviour changes, such as the following:

- Turning off the lights when they left a room or if a room was not used;
- Turning off computers, televisions and other appliances that were not being used;
- Taking advantage of using sunlight optimally;

(b) Through identifying energy waste at the school, such as:

- Checking for water being wasted in toilets and taps;
- Telling others why they should save energy and remind them to change their behaviour.

The Watt Watchers recorded wastage in the assigned areas on a daily basis and the responsible teachers or learners were issued with a ticket. After a third ticket had been issued to the same person, the co-ordinator would attempt to resolve the matter with the responsible party.

The cleaning staff at the school was also invited to be part of the project, as they were ultimately responsible for switching off lights, especially at the end of adult night classes and church services being held over weekends.

Results

Eleven faulty electricity switches in classrooms, which posed a potential danger to teachers and learners, were identified, but were only repaired after a few months as a result of administrative red tape.

As a result of the work of this group, a cost-saving of one thousand five hundred and seventy two and twenty five cents (R1572.25) was realised for the period August to December 2001 in comparison with the same period in the previous year. This saving was achieved in spite of an electricity rate increase of 9 % from July 2001 (Thomas 2002). An electricity cost and consumption analysis datasheet was received from the Cape Town City Council (see appendix v).

Figure 5-1 depicts the difference in electricity consumption (kWh) between the years 2000 (before the implementation of Watt-Watchers) and 2001 (implementation of Watt-Watchers) for the period August to December. A comparison between the two shows clearly a significant decrease in electricity consumption.

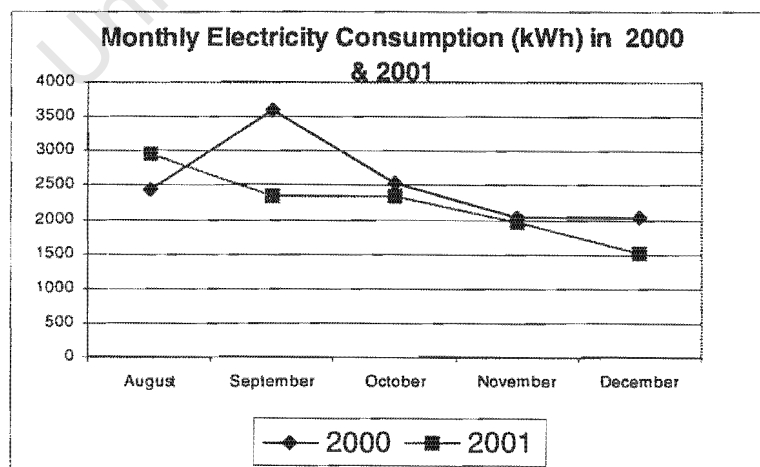
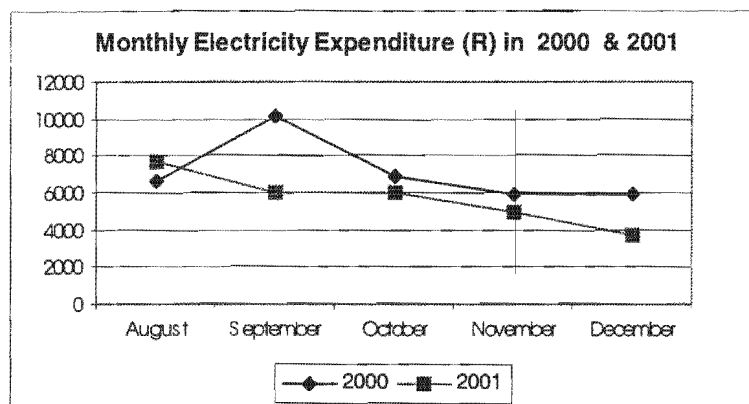


Figure 5-1: Electricity Consumption in 2000 and 2001

Figure 5-2 shows the cost saving in rand between the years 2000 (before the implementation of Watt-Watchers) and 2001 (implementation of Watt-Watchers) for the period August to



December.

Figure 5-2: Electricity Cost in 2000 and 2001

5.3 HOUSEHOLD ENERGY DATA GATHERING

5.3.1 Implementation

After learners had been introduced to a process of energy education, the second leg of the methodology, namely to cost-effectively and timeously collect and disseminate household energy data, was started. An important component of this process was also to evaluate learners' ability and willingness to collect energy data, to interpret the data and to suggest possible solutions to some of the challenges that arose.

A group of twenty-three learners (a 10% sample of a cross-section of Grades 10, 11 and 12) from Masimaphumelele participated in a household energy data gathering process. Learners from Masimaphumelele were invited to participate in this activity for the following reasons: the community uses a larger variety of traditional and modern fuels; the houses are less thermally efficient and incidents of candle fires and paraffin poisoning were more prevalent in that community. The idea was also that those learners develop solutions to the energy challenges they faced.

The accuracy and reliability of the information gathered were of paramount importance in order to evaluate the methodology. To ensure the information was reliable and up-to-date, the following strategy was applied: Learners would meet in small groups of not more than five at a time. This gave them the opportunity to express themselves freely in discussing their results. Small group dynamics provided the opportunity for rigorous evaluation of a learner's responses by fellow learners – they (learners) know the home environment and personal

circumstances of one another. Furthermore, 70% of the allocated mark was given for accurate results.

Participation by learners only earned them a 5% formative mark counting towards the year mark. Non-participants opted rather to do the less challenging assignments. Learners were not aware of any financial gains prior to the commencement of the project – the latter was rather a token of appreciation for their willingness and hard work.

There was thus little meaning for learners to participate. Their participation was rather a function of the interest that had been generated as a result of the energy education programme and a sense of community awareness.

When learners were initially approached to participate in the project, two questions arose: firstly, if it was going to earn them marks, how many; and secondly, of what value the questionnaire information would be. One student observed that quite often the people of the area were asked to complete questionnaires, and then they never saw or heard from the researchers or interviewers again. The purpose of the present research was explained to them, emphasizing that their involvement in collating and interpreting the information would only earn them minimal marks, but that it would offer them a unique opportunity to seek possible solutions to some of the challenges posed. Despite the little incentive (educationally) for learners to participate in the project, their enthusiasm was overwhelming.

5.3.2 Findings

A questionnaire was developed to determine the following (see appendix VI)

- Gender-based personal information;
- Income of household;
- Type of homestead;
- Household appliances and fuels;
- End-uses of fuels;
- Use of paraffin;
- Use of fuelwood.

5.3.4 Personal Details

Figure 5.3 illustrates the level of education of the 61 male and 84 female household members – a significantly higher number of females to males. 9 men and 17 women had no formal schooling at all. A striking phenomenon is that a much larger number of males (27) than females (25) have grade 10 to grade 12 level of education. This may be attributed to gender

discrimination or cultural factors. Only 4 males and 4 females have accredited skills (certificates and diplomas). This has a direct bearing on their employment opportunities as well as levels of income.

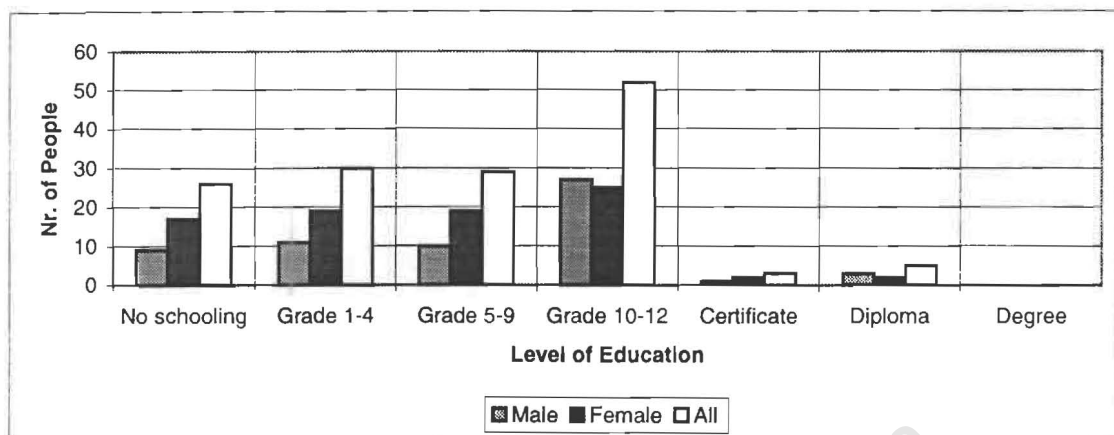


Figure 5-3: Level of Education

Figure 5.4 depicts the employment status of the target group. 19 men and 30 women were unemployed. Only 13 women hold full-time employment as opposed to 19 men. This difference in gender levels of employment may be attributed to the following: The fact that men have higher education levels (illustrated in 5-3). On the other hand, this could be due to gender discrimination or probably cultural factors, which discourage women to participate in gainful employment.



Figure 5-4: Employment Status

Figure 5.5 depicts the income levels per month. 12 out of 23 households (52,2%) earn less than one thousand rand (R1000-00) per month – a possible link between the level of education and on the one hand and levels of income. These figures paint a bleak picture about the levels of poverty.

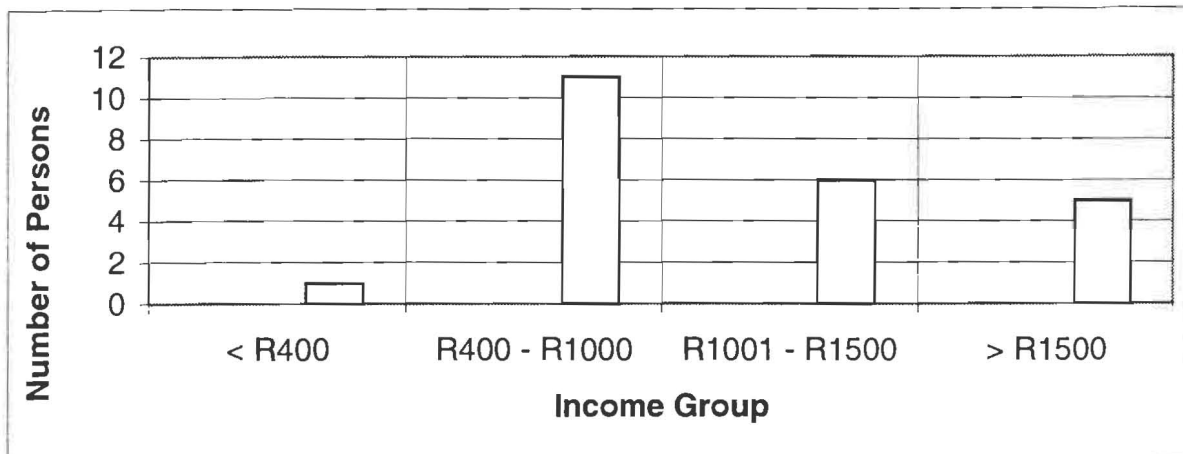


Figure 5-5: Income Levels

5.3.5 Homestead (Houses)

Figure 5.6 illustrates that seventeen of the twenty-three households surveyed (almost 74%) live in shacks with no proper insulation. 15 out of the 23 households surveyed live in at most 2 rooms. This has serious implications for individual privacy and learners studying. Almost 80% of those dwellings had no ceilings, which implied that those houses were thermally inefficient, thus requiring the use of more energy for space heating especially in winter.

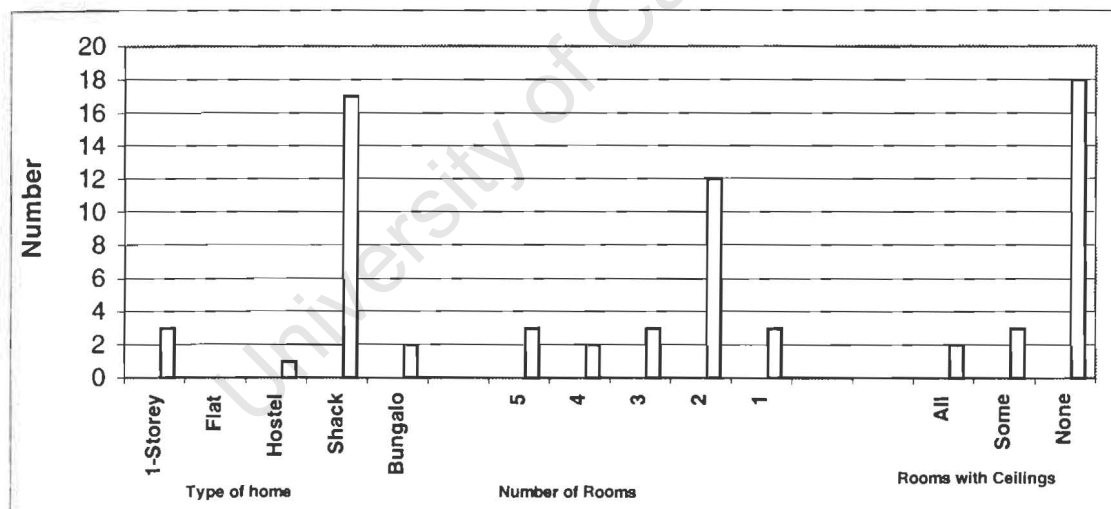


Figure 5-6: Homestead with Number of Rooms and rooms with ceilings

5.3.6 Household Appliances and Fuels

Figure 5.7 shows that the majority of households use electricity for entertainment (TV, radio) and refrigeration. A combination of electricity, wood and paraffin was used for cooking and ironing, with paraffin being the most common fuel used for ironing.

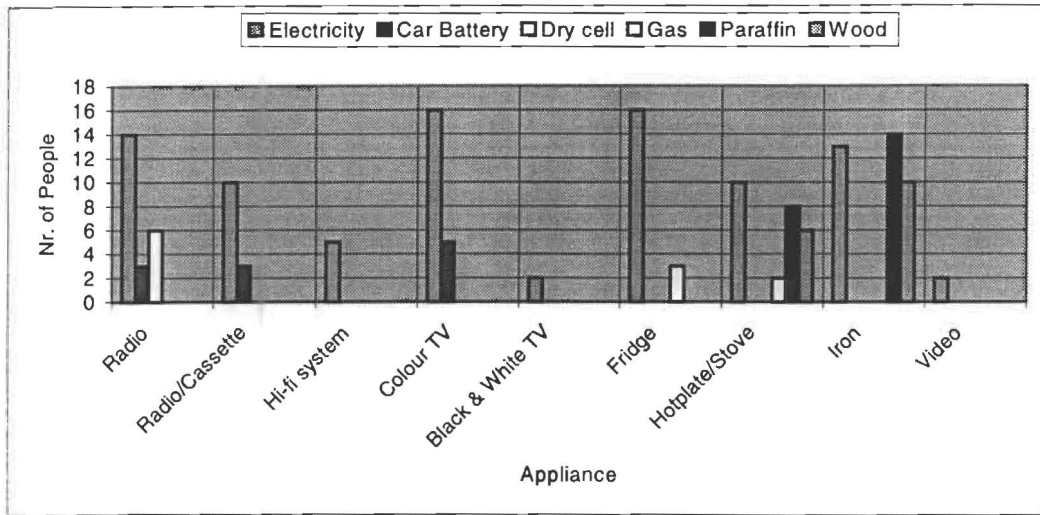


Figure 5-7: Household Appliances and Fuels

5.3.7 End-use of Fuels

All the households sampled were electrified using prepaid meter boxes. Figure 5.8 depicts the main end-use of fuels. More than 80% (19 out of 23) households use electricity for lighting, whilst candles and paraffin is used to a lesser degree. 96 % use paraffin for cooking, but the use of electricity and wood was also significant. Paraffin is also the most common fuel used for water heating followed by the use of wood. The majority of households used electricity for refrigeration and television. Electricity and paraffin were mostly used for ironing, although wood use was also significant. The ‘popularity’ of paraffin may be attributed to the fact that it could be bought in small amounts costing less than the minimum amount to buy electricity and has multiple end-uses.

The community’s heavy dependence on paraffin for cooking even though they are electrified shows their inability to afford electricity. Thus electricity is not meeting their thermal needs.

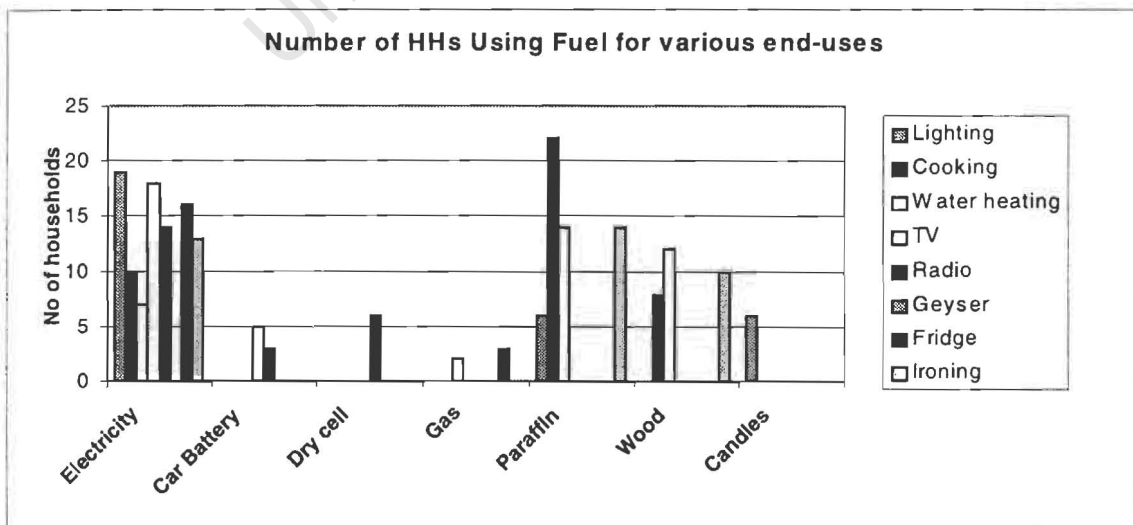


Figure 5-8: End-use of Fuels

5.3.8 Use of Paraffin

Figure 5.9 depicts the use of paraffin. 17 (73.9 %) of households used paraffin on a daily basis, and the majority buying everyday in quantities of two litres. For the majority paraffin lasts only one day. This mode of purchasing is much more expensive than buying in bulk. Poverty in the community forced people to ‘choose’ paraffin above a cleaner energy source like electricity. This scenario does not bode well for the health and safety of the people who live in small and poorly ventilated shacks.

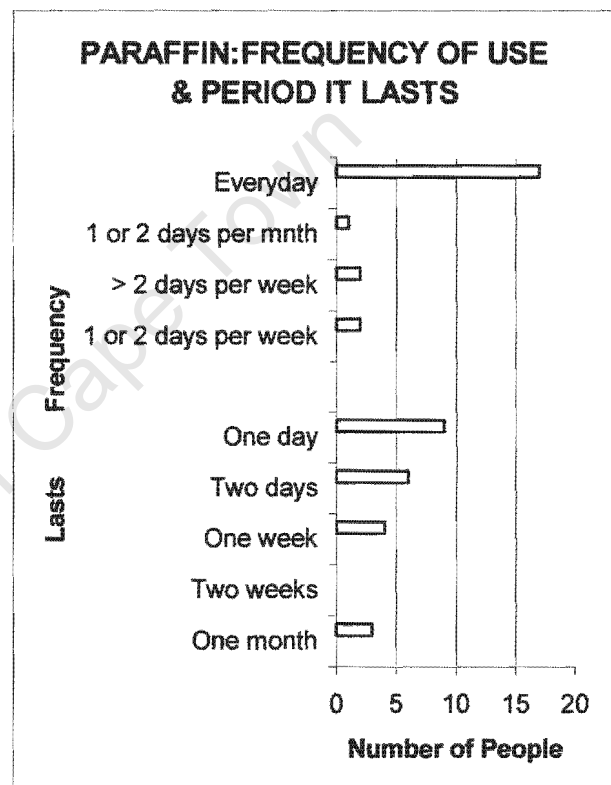
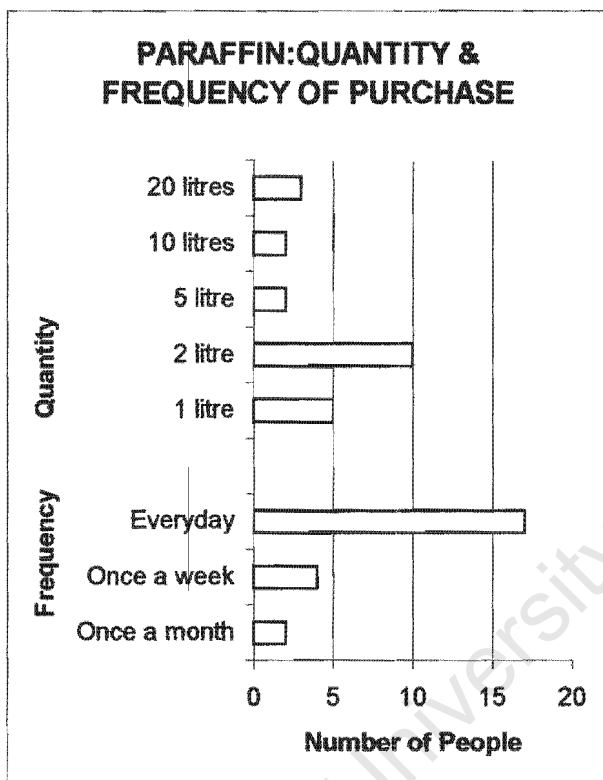


Figure 5-9: Use of Paraffin

5.3.9 Use of Fuelwood

All fuel wood users (15 out of 23) collect fuel wood in the nearby forest. Figure 5-10 shows that the majority (10) collect fuelwood once a week. They walk a distance of between 2 to 3 km, taking them about 2 hours. The levels of poverty force people to engage in environmentally destructive practices. Though they have access to electricity, their inability to afford electricity (and appliances), force them to use forest resources for their basic human needs such as heating and cooking. The gradual depletion of the forest means people will have to walk further in the future to collect wood or will be forced to buy wood.

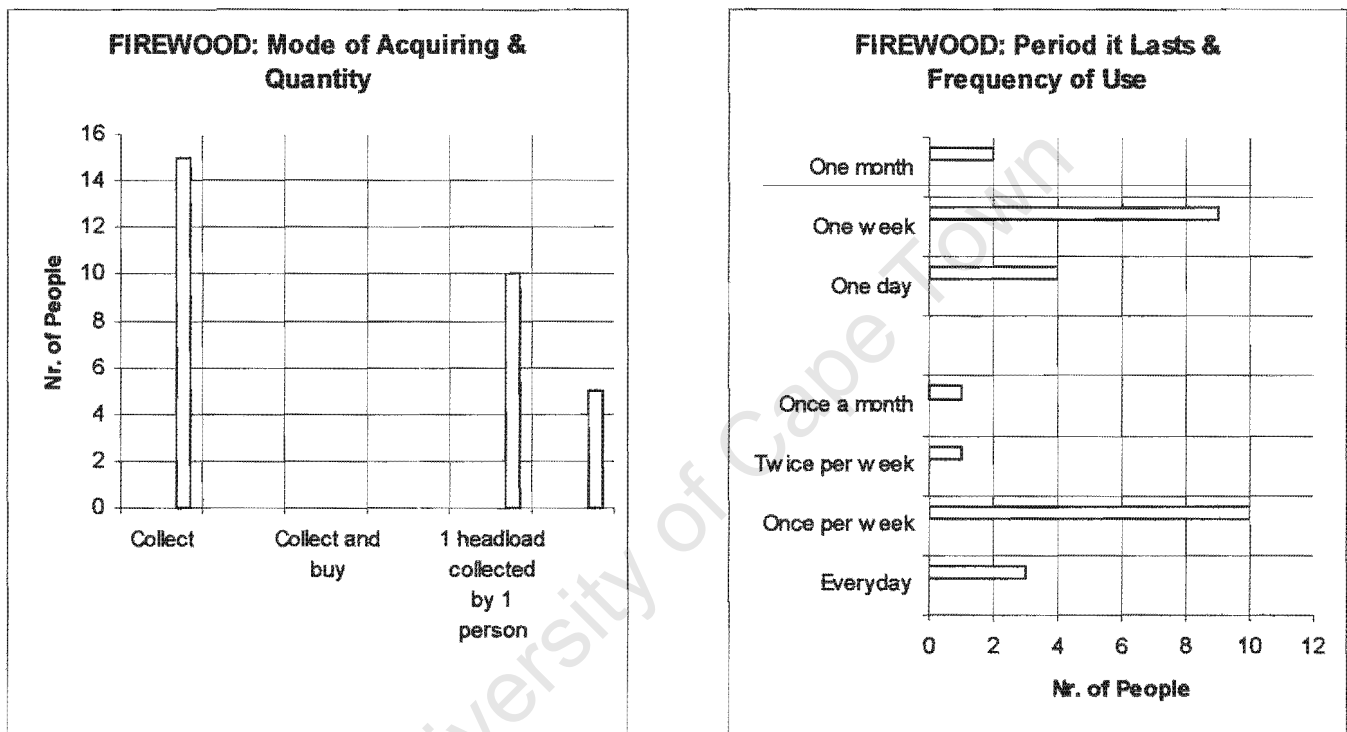


Figure 5-10: Use of Fuelwood

5.4 CONCLUSION

As can be seen from the above discussion the energy education programme has led to positive behaviour modification in learners and teachers. As a result of the Climate Change activity, learners became familiar with one of the major sources of carbon dioxide, namely the burning of fossil fuels for the production of electricity. This project assisted learners in understanding how energy use is calculated. It raised their awareness about the warming of the planet and its consequences, and all resolved to use electricity more efficiently at home and school and to inform and educate others. (see appendix II).

The energy patrol group succeeded in identifying electricity wastage at the school and through their activities effectively reduced the electricity usage for 2001 (August to December 2001) by a substantial amount in comparison with the same period in the previous year.

As a result of small group dynamics and allocating 70% of the marks for reliable and accurate information, the accuracy level of the information was very high. Learners also assisted with the compilation and interpretation of the information. Through this process learners gained a better understanding of representing and interpreting information graphically. Reliable, usable and accurate household energy information was gathered at no cost.

Learners working in small groups discussed the findings of the questionnaires and presented various solutions to the challenges and problems identified. The following were seen to be the most pressing energy needs to be addressed:

- Thermally inefficient homes – the majority do not have ceilings and wall insulation in their homes and the quality of ventilation leaves much to be desired;
- The consequences of overwhelming dependence on paraffin by the majority of households and
- The irresponsible collection of fuelwood could lead to the depletion of our natural resources.

The following solutions were offered:

Learners collected cardboard from the school and the surrounding shops to improve the thermal efficiency of their homes. Students expressed need to convey the information to others in the community and to those building homes. In addition, the importance of good ventilation was highlighted.

To minimize dependence on paraffin for cooking, learners were introduced to the idea of making ordinary solar box cookers (The 'Minimum' Solar Box Cooker 2001). They were very excited about this project, and in fact, a group of four learners manufactured a solar box cooker. This in turn had the potential to become an income generating activity.

Discussing the consequences of a dependence on paraffin and fuel usage was a great learning experience. All were familiar with the burning of shacks, children inadvertently drinking paraffin and people developing respiratory problems associated with the burning of wood and paraffin in poorly ventilated houses. This discussion raised everyone's awareness of the dangers of those fuels and the need to become less dependent on their use.

The household energy information gathered gave an excellent picture of household energy use patterns and is of profound value to policy makers and energy planners, as well as to those in community development activities in specific communities.

The objectives of the methodology and information obtained were also shared with the Valley Educational Development Trust (VEDT), a non-governmental organisation (NGO) operating in the area. They were impressed with the methodology and regarded the information as invaluable to their own community developmental projects. The VEDT could not gather information of this nature because of financial constraints and a lack of resources.

Realising the energy poverty of the community, the VEDT hoped to raise the issue with appropriate authorities and envisage the establishment of Energy Clubs to disseminate information and raise people's awareness of energy issues especially pertaining to thermally inefficient homes and dangers associated with the use of certain fuels (VEDT 2002).

The application of this methodology benefited learners intellectually and educationally, and impacted positively on some of their fellow household members.

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6. CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

This study was an attempt to demonstrate that high school learners and schools can play an important role in the gathering and dissemination of household energy information. Furthermore, it also attempted to demonstrate that energy information obtained was reliable, up-to-date and could be collected and disseminated cost-effectively and that the information could be used as a resource by energy planners and policymakers. Thus, could the proposed methodology overcome the shortcomings of the conventional method of energy information gathering and dissemination?

Firstly, it was argued that reliable and up-to-date household energy information and modelling were necessary for effective energy policymaking and planning. It discussed the potentially important role learners could play in an integrated energy planning process in order to enhance social equity, environmental sustainability, economic competitiveness and energy efficiency.

Energy education was surveyed in Industrialised and Less Developed Countries in order to be informed by international experiences – particularly in respect of the proposed methodology.

Furthermore, this study has shown that energy education is not a formal component of the national school curricula in South Africa and that this country does not have a structured and comprehensive household energy database.

In the light of the above, innovative methods are needed – thus the proposed methodology.

From the outset it was realised that to engage learners as willing partners in the collection and dissemination of household energy information, required an initiation in energy education in order for them to understand the basic concepts and issues involved. To introduce an energy education programme that was not part of the school curriculum, initially posed a major challenge because meeting the stringent demands of the current school curriculum was often too great a commitment on class time to enable new ideas to be introduced.

This thesis has demonstrated that reliable and usable data could be obtained through a process of small group dynamics and appropriate mark allocations. Furthermore, the process was cost-effective and the information could easily be updated annually by integrating household energy information gathering and dissemination with the school curricula. The

dissemination part of the methodology was however mostly confined to learners and teachers at Ocean View High School.

Community development organisations (NGOs) and local authorities are ideal vehicles to engage as partners. Through their networking with regional and national governmental structures the role of the methodology could be shared with energy planners and policymakers.

This research has also clearly demonstrated that learners benefited educationally from the programme. Engaging learners in energy information collection equipped them to make more informed decisions as far as energy usage is concerned.

However, there remain three challenges to the successful implementation of this methodology:

- Whilst energy education and energy data gathering are not part of the national curriculum and fulfilment of pass requirements, learners need to be credited academically in order to secure their support and to sustain their enthusiasm;
- Teachers' support for and their understanding of energy concepts and related issues, will to a large extent determine the success of the application of the methodology and
- Community organisations and local authorities are important partners in the process *vis-à-vis* their networking with government structures.

6.2 RECOMMENDATIONS

Although the results of the present study are promising, since it demonstrated that learners (schools) could be engaged to cost-effectively gather and disseminate usable household energy data and simultaneously benefit educationally, a research study of this nature should be conducted over a longer period of time at a number of schools of different socio-economic backgrounds, both rural and urban, as a pilot project in order to fully realise the potential of this methodology.

Critical issues affecting communities could be uncovered through the application of this methodology. Those issues should be brought to the attention of local authorities and community leaders and they in turn should inform regional and national structures (policy makers).

The DME, in collaboration with other government ministries and non-governmental organisations, should strive to educate people to better understand the role of energy in their lives, including the attendant costs and benefits. In this way energy efficiency initiatives would be more appreciated and implemented. Similarly, helping learners to understand all aspects

of a particular energy source – its availability, benefits, and monetary, environmental and social costs, will help them to make informed decisions about energy at home and at work.

As South Africa becomes more engulfed in global competition – given the scientific and digital poverty of its citizenry, there is a need to implement energy education as part of its national curriculum as a matter of urgency. Pre-service and in-service training for teachers in energy education is imperative. An energy education programme should be fully integrated into the existing curricula, be formally assessed for learners to take it seriously and should be age/grade specific.

Adult Learning Centres and Night Schools are ideal venues to gather and disseminate energy information. Credible energy information could be obtained at those venues at no cost and could easily be updated.

Questionnaires must be written in simple and understandable language. Graphical representation is a useful tool to assist the less educated.

This research has unlocked, albeit minimally, the potential role learners could play in addressing the household energy information deficit. It is hoped that this research would be further pursued.

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7. REFERENCES

1. Afrane-Okese, Y. 1995. Domestic Energy Use Analysis to Facilitate Development Strategy. Report for Technology Research & Investigations. Energy & Development Research Centre, University of Cape Town: Cape Town.
2. Afrane-Okese, Y. 1998. Domestic Energy Use Database for Integrated Energy Planning. M.Sc. Thesis. University of Cape Town: Cape Town.
3. Afrane-Okese, Y. 2002. Personal Communication. Senior Researcher. Energy & Development Research Centre, University of Cape Town: Cape Town.
4. Alliance to Save Energy. 2001 Energy efficiency for Educators. (www.ase.org/educators/index.htm)
5. ANC 1994. The Reconstruction and Development Programme. Johannesburg.
6. Bhatia, C. J. 1988. Database Development at National Level. Asian and Pacific Development Centre publication.
7. Burnett, P. 1999. Matric Learners Map Out Their Place in the Economic Sun. *Reconstruct*. October 19.
8. Census Italy. 2001. *How to Produce and Develop Good Statistics*. (www.odvsseus.it/sfabw/StatisticalCulture.html)
9. Claussen, E. "Getting it Right: Climate Change Problem Demands – Thoughtful Solutions". (www.pewclimate.org/kvoto/op-ed.cfm)
10. Cooper, C.J. 1996. Proposals for a National Energy Database and Information System. Pretoria.
11. Curriculum 2005. 1997. A Brief Overview of the Main Issues in the new South African Curriculum. Cape Town: Maskew Miller Longman.
12. Denton, F. 2000. "Gendered Impacts of Climate Change – A Human Security Dimension." *Energia News*. Vol.3. No. 3.
13. Department of Energy (United States of America) 1991/2. National Energy Strategy. Washington, D.C.: National Technical Information Service.
14. Department of Minerals and Energy (DME), 1998. White Paper on the Energy Policy of the Republic of South Africa. Vol. 402, No. 19606. Pretoria.
15. Doppegieter, J.J. and Du Toit, J. 1999. National Energy Modelling Initiatives in South Africa. *Journal of Energy in Southern Africa*. Vol. 10, No.1.

16. Eberhard, A. and Van Horen, C. 1995. *Poverty and Power: Energy and the South African State*. Energy & Development Research Centre, University of Cape Town: Cape Town.
17. Eberhard, A. and Marquard, A. 2000. "Towards Energy Equity, Efficiency and Environmental sustainability in South Africa: Policy Challenges." *Energy for Sustainable Development*. Vol. IV. No. 4.
18. ECW (Energy Center of Wisconsin). 2001. (www.ecw.org/resums/177s.html)
19. Ellis, G. 1999. Paper delivered to the Centre for the Advancement of Science and Maths Education. University of Natal.
20. Energy Information Agency (EIA). 1995. Housing Characteristics: Residential Energy Consumption Survey. Washington: U.S. Department of Energy.
21. Energy Research Institute. 2000. *Energy Management News*. Vol. 6. Nr.2.
22. Energy Smart Schools. 2001. www.eren.doe.gov/energysmartschools
23. Goldemberg, J. et. al. 1994. Energy for a Sustainable World. New Delhi: Wiley-Eastern Limited.
24. Golding, T. 2000. Personal communication. Deputy Director of Energy Planning. Department of Minerals and Energy. Pretoria.
25. Green Schools. 2001. (www.ase.org/greenschools/about.htm)
26. Hazelton, D.G. and Harris, J. 2000. "Pilot Study for Collection and Use of Data on Rural Village Water and Sanitation in South Africa". *SA Waterbulletin*. Vol.26. No.4.
27. Huggets, A.C. and Blomkamp, Y. 1987. Energy Statistics and Indicators. Energy Research Institute, University of Cape Town: Cape Town.
28. International Energy Agency. 1996. Energy Policies of South Africa Survey. Student notes. Energy & Development Research Centre, University of Cape Town: Cape Town.
29. International Energy Agency (IEA) Report. 2000. (www.iea.org)
30. Mehlwana, A.M. and Qase, N. 1996a. Social Determinants of Energy Use in Low-income Urban Households in the Western Cape. Report No. EO9420. Pretoria: Department of Minerals and Energy.
31. Loon, M. 1996. Integrated Energy Planning in Rural South Africa. Pretoria: Department of Mineral and Energy Affairs.
32. McGettrick, P. 2001. "Lessons to be Learned". www.developments.org.uk/data

33. Munasinghe, M. 1990. Energy Analysis and Policy: Selected Works. London: Butterwoths.
34. National Energy Strategy (NES). 1991/2. Powerful Ideas for America. Washington: Department of Energy.
35. National Energy Education and Development (NEED). 2001.Energy Education. (www.need.org/info.html)
36. PARIS 21. 2000. A new international process to build Statistical Capacity as the Foundation for Effective Development Policies. (www.paris21.org/htm/background.htm)
37. Prasad, K.K. 1994. "Editorial." *Energy for Sustainable Development*. Vol.1 No.2.
38. Rault-Smith, J. 2001. Personal Communication. Chief Curriculum Planner, Western Cape Education Department. Cape Town.
39. Reddy, A.K.N. 1991. "Barriers to improvement in energy efficiency." *Energy Policy*. Vol.19.
40. Reddy, A.K.N. 1994. "Electricity Planning in India: Current Approach and Resulting Problems." Module for IEI Workshop on Integrated Energy Planning. Bangalore: IEI.
41. Richardson, B. 2001. Green Schools. "An investment in our children's future." (www.ase.org/greenschools/about.htm)
42. Shell Foundation. 2001. "Sustainable Energy Programme." (www.shellfoundation.org/resources/library/SEP)
43. Sinclair, S. 2001. "Developing a Global Dimension in the School Curriculum." (www.globaldimension.org.uk).
44. Statistics Canada. 2001.Educational Resources. (www.statcan.ca/english/edu/index.htm)
45. Teri Energy Data Directory and Yearbook. 1999/2000. Overview of the Indian Energy Sector.
46. Teri Energy Data Directory and Yearbook. 1999/2000. Rural Energy Matters: Dhanawa's Experience.
47. Thai-Danish Cooperation on Sustainable Energy. 1999. "Integration of Energy and Environmental Curriculum at School." *Energy and Environment*. Vol. 6. June-August.
48. The "Minimum" Solar Box Cooker. (<http://www.solarcooking.org/minimum.htm>)
49. Thomas, E. 20002. Personal Communication. Senior Administrative Officer. City of Cape Town Electricity Department. Cape Town.

51. Trollip, H. 1994. "Energy Demand Information for Integrated Energy Planning." Paper No. 5. Cape Town: EDRC.
52. Valley Educational and Development Trust (VEDT). 2002. Personal Communication with the management.
53. Van Horen, C. 1994. "Household Energy and Environment." Paper No. 16. Cape Town: EDRC.
54. Visagie, E.F. 2001. "An Investigation into the Gathering and Dissemination of Household Energy Data in South Africa." Energy Policy Project, M.Phil-Thesis. University of Cape Town: Cape Town.
55. Visser, W. "Companies Must Buckle Up for Climate Change." *Sunday Times*. 17/12/2000.
56. World Bank Report. 1999. "Consequences of Energy Policies for the Urban Poor." *Energy Issues*. Energy Note No. 7.
57. World Bank. 2000. Statistics in Africa. (<http://www4.worldbank.org>)
58. World Energy Council. 1999. The Challenge of Rural Energy Poverty in Developing Countries. London: WEC.
59. World Energy Council. 2000. "The Challenge of Rural Poverty in Developing Countries." www.worldenergy.org)

APPENDIX I: Energy Education Questionnaire

**OCEAN VIEW HIGH SCHOOL
STUDENTS AND EDUCATORS
MAY 2001**

*Students must complete SECTION A only.
Educators must complete SECTIONS A and B.*

SECTION A

1. What is ENERGY? / What is it all about?

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2. What do you understand by ENERGY EFFICIENCY, ENERGY CONSERVATION and Energy consumption? How do these issues relate to our every day lives?

(a) ENERGY EFFICIENCY:

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(b) ENERGY CONSERVATION:

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(c) ENERGY CONSUMPTION:

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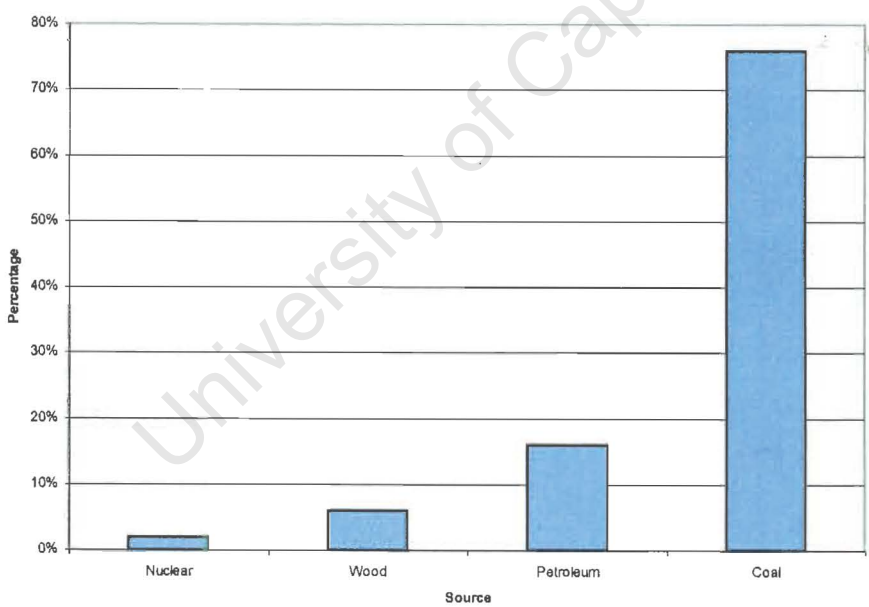
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3. The accompanying diagram illustrates the estimated primary energy usage in South Africa:

Primary Energy Usage in South Africa



(a) Which primary energy source contributes most to South Africa's energy usage?

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(b) Classify the energy sources as RENEWABLE and NON-RENEWABLE:

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4. What does this energy usage pattern mean for the present and future South African society?

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5. What are potential solutions to this problem?

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.....
.....
.....
.....
.....
.....
.....
.....

6. Millions of South Africans still do not have access to electricity and rely on less clean fuels for their energy needs. Fuels used include: paraffin (kerosene), gas, coal, candles, wood, dung, car batteries, dry cells, petrol and diesel. Next to each fuel list any problems or possible dangers associated with the use of that particular fuel:

(a)

Paraffin:.....
.....
.....

(b)

Gas:.....
.....
.....

©Coal:.....
.....
.....

(d)
Candles:.....
.....
.....

(e) Wood and
dung:.....
.....
.....

(f) Car
batteries:.....
.....
.....

(g) Dry
cells:.....
.....

(h) Petrol and
diesel:.....
.....
.....

SECTION B (To be completed by educators)

7. Do you think there is a need to include energy studies or energy related issues as part of our national school curriculum? Motivate.

.....
.....
.....
.....

APPENDIX II

MATHEMATICS TASK HG AND SG

GRADE 12

JULY 2001

NAME:

TOPIC: CALCULATING MY/OUR CONTRIBUTION TO THE GREENHOUSE EFFECT - CLIMATE CHANGE

BACKGROUND

Carbon dioxide CO_2 is considered the largest contributor to the greenhouse gases. Approximately 95% of the electricity produced in South Africa, come from coal-fired power stations (ESKOM). Coal burning is our largest source of carbon dioxide, the major greenhouse gas.

Many scientists believe that greenhouse gas emissions contribute directly to the warming of our planet and the concomitant climate change (see handout about greenhouse effects).

Electric companies (ESKOM) bill their clients in terms of kilowatts. One kilowatt is equal to 1,000 watts. If a 100-watt light bulb is left on for 10 hours, one kilowatt hour (KWh) of electricity is used. Suppose a 100-watt bulb, serving as an outside night light, is left on for eight hours a night, 365 days a year. This bulb would have consumed 292 KWh of electricity a year $(9365 \times 8 \times 100) / 1,000 = 292 \text{KWh}$. By knowing the watt rating of a particular appliance and the amount of time the appliance is used for, it is possible to calculate the amount of carbon dioxide emitted in the process of producing the electricity needed to 'power' the appliance.

TASK: How much CO_2 do you put into the environment each day by your use of electricity? Keep an Energy diary for one day.

1. Keep a record of each time you use electricity in your home for one day. Record the name of the appliance and the amount of time you used it for. Write down the Watt rating of the appliance. Be sure to consider the appliance left on like the refrigerator. (a) Determine the total amount of CO_2 emissions caused by your use of electricity for that one day.

REMEMBER: 1 KWh will emit approximately 2.34 kg of CO_2)

(b) Which items on your list consumed the most electricity?

2. Draw up an Energy Diet Plan for your home. Get each member of your family to commit to making at least one change aimed at saving electricity. Be sure to let them decide what they would like to cut back on. Ask them to specify the length of time each person would be involved. In the end, determine the amount of CO_2 emissions saved by your family.

OUR CONTRIBUTION TO CLIMATE CHANGE

University of Cape Town

My amount of CO₂ given out every day by using electricity

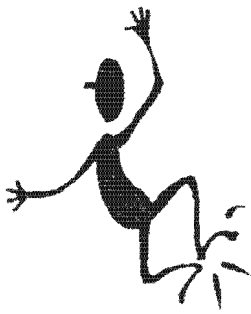
<i>Appliance</i>	<i>Watt</i>	<i>Time</i>	<i>KWH</i>	<i>CO₂</i>
<i>Tape</i>	<i>600</i>	<i>0.25</i>	<i>0.15</i>	<i>0.351</i>
<i>Kettle</i>	<i>2000</i>	<i>0.05</i>	<i>10</i>	<i>23.4</i>
<i>Fridge</i>	<i>3000</i>	<i>24.00</i>	<i>72</i>	<i>168.48</i>
<i>Oven</i>	<i>9000</i>	<i>1.00</i>	<i>9</i>	<i>21.06</i>
<i>Geysler</i>	<i>12000</i>	<i>24.00</i>	<i>288</i>	<i>673.92</i>
<i>Computer</i>	<i>70</i>	<i>1.40</i>	<i>0.098</i>	<i>0.22932</i>
<i>Hairdryer</i>	<i>1300</i>	<i>0.15</i>	<i>0.0195</i>	<i>0.04563</i>
<i>Iron</i>	<i>1200</i>	<i>0.10</i>	<i>0.012</i>	<i>0.02808</i>
<i>Stove</i>	<i>7000</i>	<i>0.17</i>	<i>1.19</i>	<i>2.7846</i>
<i>Freezer Box</i>	<i>4000</i>	<i>24.00</i>	<i>96</i>	<i>224.64</i>
<i>Toaster</i>	<i>750</i>	<i>0.5</i>	<i>0.0375</i>	<i>0.08775</i>
<i>Microwave oven</i>	<i>5000</i>	<i>0.10</i>	<i>0.5</i>	<i>1.17</i>
<i>Gloves</i>	<i>100</i>	<i>2.30</i>	<i>0.23</i>	<i>0.5382</i>
<i>Heater</i>	<i>2000</i>	<i>0.30</i>	<i>0.6</i>	<i>1.404</i>

My Family's amount of CO₂ given out every day by using electricity

<i>Appliance</i>	<i>Watt</i>	<i>Time</i>	<i>KWH</i>	<i>CO₂</i>
<i>Tape</i>	<i>600</i>	<i>1.45</i>	<i>0.87</i>	<i>2.0358</i>
<i>Kettle</i>	<i>2000</i>	<i>0.45</i>	<i>0.9</i>	<i>2.106</i>
<i>Fridge</i>	<i>3000</i>	<i>24.00</i>	<i>72</i>	<i>168.48</i>
<i>Oven</i>	<i>9000</i>	<i>3.00</i>	<i>27</i>	<i>63.18</i>
<i>Geyser</i>	<i>12000</i>	<i>24.00</i>	<i>288</i>	<i>673.92</i>
<i>Computer</i>	<i>70</i>	<i>4.30</i>	<i>0.301</i>	<i>0.70434</i>
<i>Hairdryer</i>	<i>1300</i>	<i>4.05</i>	<i>0.5265</i>	<i>1.23201</i>
<i>Iron</i>	<i>1200</i>	<i>0.45</i>	<i>0.054</i>	<i>0.12636</i>
<i>Stove</i>	<i>7000</i>	<i>3.30</i>	<i>23.1</i>	<i>54.054</i>
<i>Freezer Box</i>	<i>4000</i>	<i>24.00</i>	<i>96</i>	<i>224.64</i>
<i>Toaster</i>	<i>750</i>	<i>1.30</i>	<i>0.0975</i>	<i>0.22815</i>
<i>Microwave oven</i>	<i>5000</i>	<i>0.35</i>	<i>1.75</i>	<i>4.095</i>
<i>Globes x12</i>	<i>100</i>	<i>11.30</i>	<i>1.356</i>	<i>3.17304</i>
<i>Heater</i>	<i>2000</i>	<i>2.00</i>	<i>4</i>	<i>9.36</i>

My Family's energy diet plan

<i>Appliance</i>	<i>Watt</i>	<i>Time</i>	<i>KIVH</i>	<i>CO₂</i>
<i>Tape</i>	<i>600</i>	<i>0.45</i>	<i>0.27</i>	<i>0.6318</i>
<i>Kettle</i>	<i>2000</i>	<i>0.45</i>	<i>0.9</i>	<i>2.106</i>
<i>Fridge</i>	<i>3000</i>	<i>24.00</i>	<i>72</i>	<i>168.48</i>
<i>Oven</i>	<i>9000</i>	<i>1.00</i>	<i>9</i>	<i>21.06</i>
<i>Geyser</i>	<i>12000</i>	<i>24.00</i>	<i>288</i>	<i>673.92</i>
<i>Computer</i>	<i>70</i>	<i>2.15</i>	<i>0.1505</i>	<i>0.35217</i>
<i>Hairdryer</i>	<i>1300</i>	<i>2.00</i>	<i>0.26</i>	<i>0.6084</i>
<i>Iron</i>	<i>1200</i>	<i>0.50</i>	<i>0.06</i>	<i>0.1404</i>
<i>Stove</i>	<i>7000</i>	<i>2.30</i>	<i>16.1</i>	<i>37.674</i>
<i>Freezer Box</i>	<i>4000</i>	<i>24.00</i>	<i>96</i>	<i>224.64</i>
<i>Toaster</i>	<i>750</i>	<i>0.30</i>	<i>0.0225</i>	<i>0.05265</i>
<i>Microwave oven</i>	<i>5000</i>	<i>0.25</i>	<i>1.25</i>	<i>2.925</i>
<i>Globes x12</i>	<i>60</i>	<i>10.00</i>	<i>0.72</i>	<i>1.6848</i>



Results

My Total amount of CO₂ = 1118.13858kg

My Family's total amount of CO₂ = 1207.33506kg

This is bad for the ozone layer

So we tried cutting short the minutes and replacing the Globes with a less wattage and this was the results

After putting my family through the test where they would be able to save on watts the results was Good

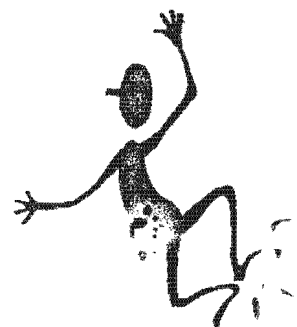
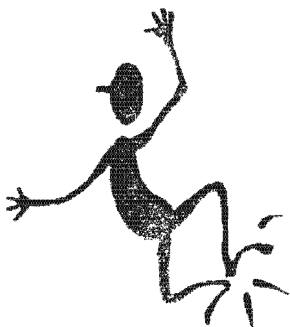
Total = 1134.35082kg of CO₂ that was being used

The difference was = 1207.33506kg

-1134.35082kg

difference 72.98478kg

Done By:
Deidre Cronje





APPENDIX V: Cost & Consumption Analysis of Electricity Usage for Ocean View High School

COST IN RAND OF ELECTRICITY CONSUMED AT OCEAN VIEW HIGH SCHOOL: 2000 & 2001

MONTH	YEAR 2000	YEAR 2001
August	2448-16	2947-58
September	3603-64	2344-78
October	2535-55	2344-78
December	2044-73	1506-51

CONSUMPTION IN KWH OF ELECTRICITY AT OCEAN VIEW HIGH SCHOOL: 2000 & 2001

MONTH	YEAR 2000	YEAR 2001
August	6643	7650
September	10103	6009.5
October	6918	6009.5
November	5936.5	4973
December	5936.5	3669

.The above analysis was supplied by Mr. E T Thomas of the Cape City Council: Electricity Department

University of Cape Town

APPENDIX VI

OCEAN VIEW SECONDARY SCHOOL

QUESTIONNAIRE

CONFIDENTIAL

All the information obtained by means of this questionnaire will be treated as strictly confidential and will be used for research purposes only.

1. PERSONAL INFORMATION

No. of Household members		Highest level of education		Employment status	
Male	[]	M	F	M	F
Female	[]				
		No schooling	[]	Employed:	
		Grade 1 – 4	[]	Full-time	[]
		Grade 5 – 9	[]	Part-time	[]
		Grade 10 – 12	[]	Self-employed	[]
		Certificate N1 – N6	[]	Housewife	[]
		Diploma	[]	Students	[]
		Degree	[]	Children not at school	[]
				Pensioner	[]
				Disabled	[]

2. INCOME OF HOUSEHOLD PER MONTH (Please indicate with a ✓)

How much?	
Less than R400	<input type="checkbox"/>
R400 – R1000	<input type="checkbox"/>
R1001 – R1 500	<input type="checkbox"/>
R1001 – R1 500	<input type="checkbox"/>
More than R1500	<input type="checkbox"/>

3. HOMESTEAD (HOUSE) (Please indicate with a ✓)

What type of homestead/dwelling do you have?	
Traditional homestead	<input type="checkbox"/>
Flat	<input type="checkbox"/>
Mixture of traditional huts and other buildings	<input type="checkbox"/>
Informal house (shack)	<input type="checkbox"/>
Bungalow	<input type="checkbox"/>
Other (specify).	
How many buildings form part of the homestead?	[]
How many rooms do you have altogether?	[]
Is there a ceiling in the house, or in some rooms of the homestead?	
Ceiling in all rooms	<input type="checkbox"/>
Ceiling in some rooms	<input type="checkbox"/>
No ceiling	<input type="checkbox"/>
Are you still building a house at the moment?	Yes <input type="checkbox"/> No <input type="checkbox"/>

6. USE OF PARAFFIN

Do you use paraffin?	Yes <input type="checkbox"/> No <input type="checkbox"/>
If yes, answer the following questions:	
How often do you generally buy paraffin?	<input type="checkbox"/>
Once a month	<input type="checkbox"/>
Once a week	<input type="checkbox"/>
Everyday	<input type="checkbox"/>
Other (specify)	
How much paraffin do you normally buy at one time?	<input type="checkbox"/>
1 litre	<input type="checkbox"/>
2 litres	<input type="checkbox"/>
5 litres	<input type="checkbox"/>
10 litres	<input type="checkbox"/>
20 litres	<input type="checkbox"/>
Other (specify)	
How long does this paraffin last?	<input type="checkbox"/>
One month	<input type="checkbox"/>
Two weeks	<input type="checkbox"/>
One week	<input type="checkbox"/>
Two days	<input type="checkbox"/>
One day	<input type="checkbox"/>
Other (specify)	
How much do you pay for the paraffin you buy?	
For 1 litre.....	
For 5 litres	
For 10 litres	
For 20 litres	
Other (specify)	
How often do you use paraffin as a fuel, (eg. For cooking, ironing, heating water, fridge)	
Everyday	
One or two days per week	
More than two days per week	
One or two days per month	
Less often	
Other (specify)	

7. USE OF WOOD (FUELWOOD)

Do you use any firewood?	Yes <input type="checkbox"/> No <input type="checkbox"/>
If yes, answer the following questions:	
Do you collect firewood or buy firewood or do both?	
Collect firewood	
Buy firewood	
Collect and buy firewood	
If you collect, answer the following questions:	
How long is the return trip to collect firewood in hours/km?	
 km/hours by car
 km/hours when walking
 Other

Where do collect firewood? On the hill? <input type="checkbox"/> On the forest? <input type="checkbox"/> On the farm? <input type="checkbox"/> Other (specify) <input type="checkbox"/>
How much firewood do you generally collect at one time? One headload collected by one person <input type="checkbox"/> Two headloads collected by two people. <input type="checkbox"/>
What type of firewood do you collect? Green <input type="checkbox"/> Dead <input type="checkbox"/>
Why?
How often do you collect firewood? Everyday <input type="checkbox"/> Once per week <input type="checkbox"/> Twice per week <input type="checkbox"/> Other (specify) <input type="checkbox"/>
How long does the firewood last? One day <input type="checkbox"/> One week <input type="checkbox"/> Other (specify) <input type="checkbox"/>
If you buy firewood, answer the following questions:
How much firewood do you generally buy at one time? Bakkie load <input type="checkbox"/> Headload <input type="checkbox"/> Wheelbarrow <input type="checkbox"/> Other <input type="checkbox"/>
How much do you pay for this firewood? For a bakkie load Wheelbarrow load Other (specify)
How long does this firewood last? Two months <input type="checkbox"/> Month <input type="checkbox"/> Other (specify) <input type="checkbox"/>
What are all the things you do with firewood? Cooking <input type="checkbox"/> Ironing <input type="checkbox"/> Lighting <input type="checkbox"/> Heat water <input type="checkbox"/> Warm yourselves <input type="checkbox"/> Baking <input type="checkbox"/> Sitting and chatting <input type="checkbox"/> Other (specify) <input type="checkbox"/>
How often do you use firewood? Everyday <input type="checkbox"/> One or two days per week <input type="checkbox"/> More than two days per week <input type="checkbox"/> One or two days per month <input type="checkbox"/> Other (specify) <input type="checkbox"/>