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Accelerating the Market Penetration of Renewable Energy Technologies in South Africa

Available on the Internet at http://www.uccee.org/RETSouthAfrica

Preface

This report is the final publication under the European Commission Synergy Programme project "Strategy to accelerate the Market Penetration of Renewable Energy Technologies in South Africa", registered under contract number 4.1041/D/99-033. The Netherlands Energy Research Foundation ECN (co-ordinator), CSIR, Risoe National Laboratory through the UNEP Collaborating Centre on Energy and the Environment, and Richard Morris and Associates have carried out this project between December 1999 and March 2001. Authors of the report are:

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The rationale for this Synergy project evolved during the execution of a European Commission THERMIE Programme co-funded project entitled "Renewable energy sources for rural electrification in South Africa". This project was done under contract number STR/1388/97-GB and was co-funded by the CSIR. The project partners were the CSIR, Garrad Hassan & Partners Ltd and the Netherlands Energy Research Foundation (ECN). The primary objective of the THERMIE project was to identify commercially viable opportunities for rural electrification in the Eastern Cape Province of South Africa. It became clear that there were many barriers that prevent the more widespread use of renewable energy in South Africa and the CSIR initiated the formulation of this Synergy project. It is intended that the resultant Action Plan developed in the Synergy project will contribute towards overcoming these barriers.

During the research stakeholder analysis was carried out from 7 to 17 August in South Africa. During the stakeholder analysis, various stakeholders in the South African renewable energy sector have been interviewed, including representatives of renewable energy industry, the Solar Energy Society of South Africa Department of Minerals and Energy, ESKOM, research institutes, municipality and private consultants. At the end of the project, the results of the study have been discussed at a 2 - day workshop at the CSIR premises in Pretoria. The proceedings of the workshop are on the Internet: http://www.uccee.org/RETSouthAfrica/workshop.htm or http://www.ecn.nl/unit_bs/resa/main.html. The project team would like to express its sincere gratitude to all those who have taken their time and effort to provide us with information and their views on the various aspects of renewable energy in South Africa. These inputs have considerably improved the quality of our work. The remaining flaws and errors are of course entirely our own responsibility.

The mentioning of the term "strategy" in the title of this study is somewhat misleading. The aim of this study is not to present an overarching strategy which substitutes the current initiatives in South Africa with a new one. We believe that such a task is beyond the scope of a team of outside researchers. Rather we have attempted to incorporate current initiatives in our analysis and complement them with our own recommendations. Apart from existing policy initiatives we have also attempted to complement existing studies in the research field. Particular reference should be made to the DANCED/DME study on Bulk Renewable Energy Independent Power Producers (DANCED, 2001), which provided major input in recommendations for grid-connected renewable energy.

This study was awarded funding under the EU Synergy Programme in 1999. Besides the European Commission Synergy Programme each of the respective participating organisations contributed half of their expenses under this project. The support from the European Commission and each participating organisation has been highly appreciated. The funding by the EU does by no means imply that this report contains EU-statements. The responsibility of the text, including its inevitable flaws, remains with the authors.

CONTENTS

Section III - Recommended Actions to Stimulate the Market Penetration of Renewable Energy Technologies in South Africa

LIST OF ACRONYMS AND ABBREVIATIONS

€	Euro
AEBIOM	European Biomass Association
AEC	Atomic Energy Corporation
AIJ	Activities Implemented Jointly
AMEU	Amalgamated Municipal Electricity Undertakings
ANC	African National Congress
Bcm	Billion cubic metres
BIT	Bilateral
BOO	Build, Own, Operate
BOS	Balance Of System
CAM	Wind Analysis programme
CARI	Spanish Agreement on Reciprocal Adjustment of Interest Rates
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CESCE	Spanish Export Credit Insurance Company
CNS	Council for Nuclear Safety
CO_2	Carbon Dioxide
COGEN	European Association for the promotion of Cogeneration in Europe
COP	Conference of the Parties
CPPP	Community Public Private Partnerships
CSIR	South African scientific research council
DACST	Department of Arts, Culture, Science and Technology
DANCED	Danish Co-operation for Environment and Development
DBSA	Development Bank of Southern Africa
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Minerals and Energy
DoH	Department of Housing
DTI	Department of Trade and Industry
DWAF	Department of Water Affairs and Forestry
EC	European Commission
ECCP	European Climate Change Programme
ECN	Netherlands Energy Research Foundation
EDF	Electricité de France, French National Utility
EDI	Electricity Distribution Industry
EDRC	Research and Development Centre
EFTA	European Free Trade Associations
EOLE	French Utility Wind Energy Programme
ESI	Electricity Supply Industry
ESKOM	South Africa's National electricity utility
ET	Emissions Trading
EU	European Union
FAD	Spanish Development Aid Fund
FEV	Spanish Fund for Feasibility Studies
FFS	Fee For Service
FIB	Friedenheim Irrigation Board
GDP	Gross Domestic Product
GEAR	Ingredients of RDP: Growth, Employment and Redistribution
GEF	Global Environmental Facility
GEF	Global Environment Facility
GGP	Gross Geographical Product

GoSA	Government of South Africa
GSR	Guarantee of Solar Results
GWh	Giga (10^9) Watt Hour
ICEX	Spanish Foreign Trade Institute
IDC	Industrial Development Corporation
IDP	Integrated Development Planning
IDT	Independent Development Trust
IEP	Integrated Energy Planning
IPP	Independent Power Producer
IPPF	Investment Project Preparation Fund
IRP	Integrated Resource Planning
ISRD	Integrated Sustainable Rural Development
ISRE	Implementation Strategy for Renewable Energy
JOULE	Non-Nuclear RTD Programme of the European Union
KVA	Kilo Volt Ampère, measurement of power
KWh	Kilo Watt Hour, measurement of power
LPG	Liquid Propane Gas
MEPC	Mineral & Energy Policy Centre
MW	Mega Watt (or 10^6) Watt
MW_p	Mega Watt Peak
NAFTA	North American Free Trade Agreement
NCCC	South African National Climate Change Committee
NEF	National Electrification Fund
NER	National Electricity Regulator in South Africa
NFFO	Non-fossil Fuel Obligation
NFPA	Non-Fossil Purchasing Agency
NGEP	Non-Grid Energy Plan
NREL	National Renewable Energy Laboratory, USA
NRTF	National Research and Technology Foresight Study
Nufcor	Nuclear Fuel Corporation
NUON	Large Dutch Utility
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
ORET/MILIEV	Dutch Export Promotion Programme
PESP	Dutch Programme Economic Co-operation Projects
PIMS	Planing and Implementation Management Support
PJ	Pèta (or 10^{15}) Joule
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PSOM	Dutch Programme Co-operation Upcoming Markets
R	Rand
R&D	Research & Development
RDP	Reconstruction & Development Plan
RE	Renewable Energy
REC	Regional Electricity Companies
RED	Regional Electricity Distribution Companies
RES	Renewable Energy Sources
RISØ	Danish National Research & Technology Centre
RTD	Research Technology Development
SA	South Africa
SABRE-Gen	South African Bulk Renewable Energy – Generation
SADC	Southern African Development Community
SDI	Spatial Development Initiative
SHS	Solar-Photovoltaic Home System
SLOT	School Leaver Operational Training

SME	Small and Medium Sized Enterprises
SWOT	Strength, Weakness, Opportunities, Threats
The Government	The national Government of the Republic of South Africa
THERMIE	Demonstration Component of the Non-Nuclear RTD Programme of the European Union
TWh	Tera (10^{12}) Watt Hour
UNDP	United Nations Development Programme
UNFCCC	The United Nations Framework Convention on Climate Change
VAT	Value Added Tax
WASP	Wind Atlas Analysis and Application Programme
WPEP	White Paper on Energy Policy

Executive Summary

Renewable energy has the potential to contribute to a number of key challenges in South Africa, in particular in providing cost effective modern energy services in rural areas and facilitating job creation. The White paper on the Energy Policy indicates clearly that in the past, South Africa has neglected the development of renewable energy applications. To address this problem, the Government intends to formulate policy specifically oriented towards renewable energy. The policy is meant to: 1) ensure that economically feasible technologies are implemented; 2) ensure that an equitable level of national resources is invested in renewable technologies; and 3) to address the constraints on the development of the renewable industry.

The Member States of the EU on the other hand have acquired considerable knowledge and experience on the issue of how government and market initiatives can be used to overcome financial and institutional barriers in renewable energy development. These European initiatives can broadly be divided into the following three categories: 1) R&D efforts aimed at long term cost reduction of renewable energy technologies; 2) Measures to stimulate the market penetration of renewable energy technologies; 3) Improvements of the institutional and regulatory framework.

Therefore a study has been formulated with the objective to develop a strategy to accelerate the market penetration of renewable energy technologies in South Africa, taking into account the lessons learned by EU Member States. The study focuses on electricity generating solar, biomass, wind and mini-hydro power. First, recommendations are made on sound government policy for the implementation of renewable energy technologies. Secondly, the study identifies actions for European - South African co-operation to increase investments in renewable energy technologies in South Africa.

The enormous amount of cheap coal-based electricity and the over capacity prevailing in SA, leads to very small incentives for the development of Renewable Energy sources. However, specific drivers are found in 1) economic advantages above centralised production; 2) strive for increasing socio-economic status within communities 3) Independent Power Producers. Current activities in the field of grid-connected renewable power generation are limited to Eskom's Sabre-Gen Programme, and a number of small hydro power and biomass fired power plants. Eskom's initiatives in RE are still in their early phase.

Eskom dominates the electricity sector in South Africa, as generator, distributor and owner of the national network. IPPs in general and renewable IPPs in particular have at present extremely limited opportunities to enter in the electricity market. Currently there is no favourable market environment for large-scale penetration of grid-connected renewables. This is mainly caused by the unclear organisational and legislative framework, the ongoing restructuring of the electricity market and the competitiveness with the existing generating capacity. The market for IPPs is not likely to change during the coming 5 years.

Restructuring of the ESI is a specific mandate of the 1998 White Paper on the Energy Policy (WPEP). The model to follow is topic of current debate. Some recent indications are that ESKOM would be divided into separate transmission, distribution and generation entities, and that separate generating companies would be formed to promote internal competition prior to the introduction of private sector participation, the latter aimed at providing new power requirements. The imminent restructuring of the South African electricity sector offers the unique opportunity to build renewable-friendly provisions into the new framework.

European experiences and potential contributions

During the last decades, many European countries have gained a lot of experiences with renewable energy technologies (RE). Most EU governments now have RE as part of their national policy and have developed promotion strategies. Most of these employ several policy instru-

ments in parallel to promote the generation of electricity from renewable sources. These instruments include investment subsidies, Feed-in tariffs, Tenders, Fiscal incentives and Green certificates. In addition, other policies such as grid access and tariff regulations or local spatial planning procedures, are also very relevant in the development of the RE projects.
For RE technologies, there are generally no requirements concerning the operational quality of the equipment, such as the amount and reliability of output and the conversion efficiency. Incentives to maintain and increase operational performance can very effectively be tied to the support mechanism that is used. Furthermore, subsidies on output provide a strong incentive to improve operational performance. Support mechanisms that are based on competitive mechanisms, such as tendering and tradable green certificates, also reward RE generators for maintaining and improving continued generation, reliability and efficiency. Moreover, competitive mechanisms provide an incentive to reduce the cost of renewable electricity generation at the same time.

Although the deployment of renewable energy varies throughout the EU, the member states have in general an advanced renewable energy development programme compared to South Africa. This can be advantageous for South Africa through the experience with financial incentives and institutional arrangements and the availability of the technology. The recommended actions are based on the analysis done by the Project team, and have been discussed and prioritised at a workshop held with relevant stakeholders.

Recommendations for increased market penetration of RE in South Africa
Actions to enhance the policy framework for grid-connected renewable power generation: 1) development of a 200 MW set-aside programme; 2) Develop and implement power purchase regulation 3) Capacity building. Other policy related actions are: 1) Disseminate successes and failures 2) Integrated resource planning; 3) Improve tariff Structure; 4) Apply innovative financing; 5) Use green power marketing

Actions to enhance the policy framework for off-grid renewable energy are: 1) Government stakeholders should convey the same message 2) Raise awareness of end-users on electrification planning, the non-grid rural electrification programme, and renewable energy technologies 3) Make electrification planning more transparent 4) Integrate energy planning into Integrated Development Planning Process; 5) Capacity building to support the implementation of the non-grid electrification programme focusing on: improved monitoring and evaluation capacity at DME, NER and technical and financial assistance for concessionaires.

Other relevant actions by stakeholders include: 1) Conduct research on the optimal rural energy service structure; 2) Concessionaires should be responsible for all non-grid energy services in their concession area 3) Special risk mitigation measures for economic activities; 4) Launch integrated PV follow up programme

Off-grid renewable energy
Despite ESKOM's electrification programme, it is estimated that 3.3 million households are not connected to the grid and that 2.1 million of these will not receive ESKOM electricity in the near future. Electrification of households is one of the core objectives of the Government of South Africa and it recognises the potential role for solar home systems (SHS) and other renewable energy technologies in providing energy services to remote rural communities.

Until recently, the off-grid renewable energy market has been small. An estimated 50,000 to 80,000 SHSs have been installed, plus a number of small-scale pilot projects. The DME has developed the Non-Grid Rural Energy Programme to provide rural energy services to 300,000 households in the next 5 years, with each concessionaire being responsible for 50,000 households. In anticipation of implementation, the following hurdles may be expected:

- ESKOM/Concessionaires relations with regard to ESKOM disclosing grid extension programmes in the assigned concession areas,
- fee-for-service concept is a new approach and still needs to be proven in the South African context, especially in terms of payment discipline and ownership issues,
- social impact: if poor households cannot afford the monthly fee, the Non-Grid Electrification Programme ends up benefiting only more affluent households in rural areas,
- bad image of photovoltaic (PV) in rural areas in South Africa through fly-by-night companies that sell low-quality systems without technical backup.

Energy plays a key role in enabling rural development, such as income generation activities and rural energy provision, and facilitating social services such as health and education. The key challenge for rural energy in South Africa is therefore how development and energy can be promoted simultaneously.

Climate change support mechanisms for renewables

The EC and its member states are assisting developing countries in the implementation of their obligations within the UNFCCC. Specific priorities for funding are preparatory activities for the implementation of the Clean Development Mechanism (CDM), energy efficiency and renewable energy. The assistance is aimed at giving incentives to the private sector in the host country to invest in CDM projects and assisting governments to put in place the necessary structures for the identification, evaluation and selection of projects. Priority must be given to projects which favour the development of clean technologies and/or which involve NGOs in the process of selecting projects. Denmark, Finland, the Netherlands and Sweden already have concrete CDM initiatives.

Climate change issues are co-ordinated by the Department of Environmental Affairs and Tourism (DEAT), advised by the National Centre for Climate Change. Identified potential CDM project areas with regard to renewables are: wind farms, solar energy and electricity from biomass. For off-grid renewable energy projects to be viable within the CDM, it is recommended that the Government of South Africa adopt a special CDM window for off-grid renewable energy systems.

1. INTRODUCTION

1.1 Background: Renewable Energy in South Africa

South Africa boasts a relatively sophisticated energy sector which reflects the abundance of mineral resources (coal in particular) and economic characteristics (a significant industrial base) of the country, as well as past priorities of the Government of the day. Whilst this degree of sophistication has catered adequately for the supply of energy services to the economic sectors such as industry, mining, commerce, agriculture and transport, there is a serious problem in meeting the basic needs of a significant portion of the population, the majority of whom reside in rural areas.

On the issue of relevance to national priorities, the Government, initially through the Reconstruction and Development Programme (RDP) and through GEAR (Growth, Employment and Redistribution) has placed emphasis on economic and social restructuring to achieve sustained economic growth and development. Included in this commitment is the improvement of infrastructure, (which includes power and electricity), the broader participation of the population in the economic activities, decision making and the eradication of poverty. In the White Paper on Energy Policy attention is focused on achieving greater equity within the energy demand and supply sub-sectors, with a particular emphasis on social equity, economic efficiency and environmental sustainability.

Renewable energy has the potential to contribute to a number of key challenges in South Africa, in particular in providing cost effective modern energy services in rural areas and facilitating job creation. This has been recognised by the Government of South Africa. With regard to renewable energy, the White Paper indicates clearly that in the past, South Africa has neglected the development of renewable energy applications. To address this problem, the Government of South Africa intends to formulate policy specifically oriented towards renewable energy. The policy is meant to: 1) ensure that economically feasible technologies are implemented; 2) ensure that an equitable level of national resources is invested in renewable technologies; and 3) to address the constraints on the development of the renewable industry.

As a follow up to the White Paper, the Department of Minerals and Energy is currently formulating an Implementation Strategy for Renewable Energy. As part of their efforts to introduce modern energy services into South Africa’s deprived rural areas, the DME has initiated the Non-Grid Electrification Programme (NGEP). Acknowledging that it is impossible to electrify all of South Africa’s rural households in the near future, this programme aims at providing energy services by means of off-grid renewable energy systems, such as Solar Home Systems or hybrid mini-grid systems such solar-wind or wind-diesel systems.

1.2 European Experience

The oil crises in the seventies, but also increasing environmental concerns such as acid rain and climate change, have stimulated in the past the development and deployment of renewable energy. Over the years, the Member States of the European Union (EU) have acquired considerable knowledge and experience on the issue of how government and market initiatives can be used to overcome financial and institutional barriers in renewable energy development. Such European initiatives can broadly be divided into the following three categories:

1. Research and development efforts aimed at long term cost reduction of renewable energy technologies.

2. Measures to stimulate the market penetration of renewable energy technologies focusing on (among others):
    - Inclusion of external social costs in energy market decisions by removal of subsidies which discriminate in favour of conventional energy and new financial incentives for renewable energy technologies;
    - increased access to capital for renewable energy development.
3. Improvements of the institutional and regulatory framework which focus on:
    - Creation of a legal framework for independent power producers and power purchase agreements;
    - Spatial planning;
    - Encouragement of broad participation of stakeholders in energy decision-making.

1.3 Methodology and structure of the report

There exists a big potential for renewable energy technologies in South Africa and despite the fact that rapid growth of the application of renewable energy is taken place in many parts of the world, the current installed renewable capacity in South Africa is negligible.

The CSIR initiated and catalysed a project that it undertook with Garrad Hassan and Partners and the Netherlands Energy Research Foundation (ECN) that was entitled “Renewable energy resources for rural electrification in South Africa”. The CSIR and the European Commission THERMIE Programme co-funded this project under contract number STR/1388/97-GB. The primary objective of this THERMIE project was to identify commercially viable opportunities for rural electrification in the Eastern Cape Province of South Africa. During the execution of this project it became clear that there were many barriers that prevent the more widespread use of renewable energy in South Africa. Consequently the CSIR and ECN formulated the framework of this Synergy project and was fine-tuned with inputs from RISØ and Richard Morris and Associates. It is intended that the resultant Action Plan developed in this Synergy project will contribute towards overcoming these barriers.

The focus of the study was in particular on solar, biomass, wind and mini-hydro renewable energy technologies[1]. The outcomes of the study consist of two parts. Firstly, recommendations will be provided for supporting the formulation of sound government policy for the implementation of renewable energy technologies. These recommendations will be the result of:

- a thorough analysis of South Africa's specific constraints and barriers to renewable energy implementation.
- the consideration of current proposals on policy and strategy being discussed by government and stakeholders
- the lessons learnt from Member States of the EU on the promotion of renewable energy development.

Secondly, the study aimed at identifying actions for European - South African co-operation to increase investments in renewable energy technologies in South Africa. This actions will contain a list of potential renewable energy projects, will complement and build on existing initia-

[1] It should be noted that this analysis is limited to electricity generating renewable energy technologies. Considering the wide range of applications of renewable energy technologies and the diversity in the different markets it was felt among the project team members that clear focus was required. This focus has been put on renewable electricity generating technologies as this is the area where the most relevant linkages can be found between South Africa and Europe.

tives in South Africa and will identify opportunities for co-operation between these initiatives and the European renewable energy industry.

- Phase 1 - Review of the role of Renewable Energy in South Africa
- Phase 2 - Identification and Evaluation of Concrete Renewable Energy Projects in South Africa
- Phase 3 - Determination of the potential European contribution to renewable energy development in South Africa in terms of lessons learnt, useful technologies and investment programmes
- Phase 4 - Recommendations and dissemination of results

The first part of the project consisted of fact funding: identifying the needs and opportunities for renewable energy technologies in South Africa by means of a literature analysis (phase 1) and a stakeholder analysis (phase 2). During the stakeholder analysis, various stakeholders in the South African renewable energy sector have been interviewed, including representatives of renewable energy industry, the Solar Energy Society of South Africa, DME, ESKOM, research institutes, municipality and private consultants.

Section 1 of this report reports the results of our fact-finding. Chapter 2 provides background information on the key energy issues in South Africa. The opportunities and barriers relating to grid-connected power generation with renewable energy technologies are highlighted in Chapter 3. Chapter 4 provides an overview of the key issues pertaining off-grid renewable energy.

The second part of the project consisted of reviewing the experiences and potential contributions from Europe and identifying the potential contribution of the EU and its member States to the market of development of renewable energy in South Africa. The chapters 5, 6 and 7 in Section II provide an overview of the EU review in terms of technologies (Chapter 5), policy experiences (Chapter 6) and the promises of international climate initiatives for renewable energy collaboration (Chapter 7).

The resulting recommendations have been discussed during a final workshop in Pretoria. The workshop has resulted in re-evaluation and prioritisation of the proposed actions, which have been integrated in the recommendations of the report. Section III (Chapter 8) provides an overview of the recommended actions to further stimulate the market penetration of renewable energy technologies in South Africa. They are structured in:

- Actions to enhance the policy framework for renewable power generation;
- Actions to enhance the policy framework for off-grid renewable energy; and
- Recommendations to stimulate renewable energy project development.

Section I

Opportunities and Barriers for Renewable Energy in South Africa

2. CURRENT ENERGY ISSUES IN SOUTH AFRICA

2.1 Introduction

Describing the South African energy economy begins with its large dependence on coal, a situation that is likely to prevail deep into the 21st century. South Africa has vast untapped coal resources (see Table 2.1). Estimates show a current reserve of 55 billion ton that would be sufficient, at current production levels, for the next three centuries. The coal is the cheapest produced world-wide and has lead to the development of electricity generation plants that are of the most water efficient and that utilise the lowest grades of coal.

Table 2.1 *Energy resources of South Africa (source: Howells, 1999)*

Resource	Reserves
Coal	1 298 000 PJ
Crude oil	1 920 PJ
Natural gas	1 418 PJ
Coal bed methane	3 500 PJ
Uranium	157 853 PJ
Hydro	20 PJ/year
Wind	50 PJ/year
Solar	8 500 000 PJ/year
Wood	220 PJ/year
Agricultural waste	20 PJ/year
Municipal solid waste	34 PJ/year
Bagasse	49 PJ/year

South Africa’s dependency on coal can be seen when the total primary energy supply is analysed. Figure 2.1 shows that, in 1995, coal and imported crude oil dominate the primary consumption. ‘Other’ includes hydro and nuclear.

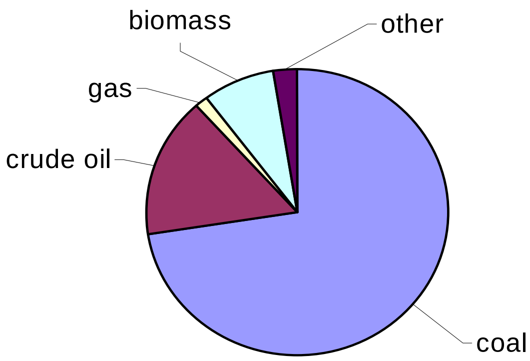

Figure 2.1 *Total Primary Energy Supply for 1995. Total: 4500 PJ (source: Howells, 1999)*

The non-conventional energy resources of South Africa itself include nuclear, limited hydropower and limited petroleum resources and the traditional biomass fuels associated with most African countries. However, the Southern African sub-continent as a whole has vast untapped conventional energy resources. This includes large hydro-power resources that are renewable in nature but often regarded as conventional, because of their impact on the local ecosystem

Electricity, generated in large power stations and transmitted and distributed through a grid, is generally accepted as the modern norm for energy supply. It is relatively easy to generate, can be transmitted over long distances and distributed geographically to consumers at comparatively low cost. Electricity is highly versatile, easily controlled and readily convertible into the required form Therefore, energy supply strategies for the future will centre largely on broadening access to electricity, especially in the developing countries.

Howells (1999) notes that the most uncertain figure in this total primary supply is for traditional biomass and the figure here is a best estimate. Traditional Biomass includes wood, firewood and dung in the residential sector, but also biomass for industrial energy, notably in the sugar and paper industry.

South Africa has an installed generation capacity of some 39 000 MW, with an extended national grid spanning some 267 000 km of high voltage transmission, distribution and reticulation lines. These at present largely owned and operated by ESKOM, the national electricity utility. The grid is interconnected with all bordering countries.

South Africa boasts the second lowest unit price of electricity in the world at 10.08 Rand[2] cents/kWh (€ 0.015/kWh), with an undertaking by ESKOM to reduce the cost of electricity further in real terms by 15% over the next decade.

Although a large potential exists for renewable energy exploitation in South Africa and despite the fact that rapid growth of the application of renewable energy is taking place in many parts of the world, the current installed renewable capacity in South Africa is negligible. As clearly indicated in the White Paper on the Energy Policy, South Africa has neglected the development of renewable energy applications (DME, 1998).

To address this problem, the Government of South Africa intends to formulate policy specifically oriented towards renewable energy. The policy is meant to: 1) ensure that economically feasible technologies are implemented; 2) ensure that an equitable level of national resources is invested in renewable technologies, given their potential and compared to investments in other energy supply option; and 3) to address the constraints on the development of the renewable industry (DME, 1998).

The electrification of households is of particular interest. It is a stated objective of the White Paper on Energy Police that ‘Government commits itself to implementing reasonable legislative and other measures, within its available resources, to progressively realise universal household access to electricity’.

However, projections of the domestic grid electrification programme show that when this programme is completed, some 20-25% of the population, or 2 to 3 million households, will still not have electricity in their homes by 2012. These are the people who live too far from the grid to be considered for economic interconnection. They live in remote communities with very dispersed housing and with a demand for electricity that is very low, rendering grid extension uneconomical. From a development perspective these communities are of the most fragile and largely representative of the ‘poorest of the poor’.

Furthermore, field experiences in the grid extension programme indicate that access to electricity does not imply immediate conversion to this energy form. The consumption in newly electrified homes is extremely low with no indication of significant growth in the short to medium

[2] 1 € ~ 7 Rand, in March 2001

term. Analysis of the ESKOM experience up to 1996 indicates that the average electricity sales per new service point is 86 kWh per month (cash flow of about R 27; €3.85), while the average variable cost of supply is R 21 (€ 3.20) per service point. The average capital cost per grid supply point, thus far mainly in the more densely settled rural and peri-urban areas, since the inception of the programme is approximately R 3417 (€ 520). The capital costs per service point are therefore practically fully subsidised.

The total subsidisation per rural electricity service point is projected to grow by factors of 2 to 3, as more remote areas are targeted. The average sales in these remote areas are well below the current national average of 86 kWh per month, with electricity largely being used for lighting and the powering of televisions and radios. These adverse economics seriously hamper the electricity distribution industry from reaching the more remote rural customer.

It is now realised that the conventional electricity network cannot economically satisfy this objective for all the communities within South Africa, especially those in the more remote rural and often underdeveloped areas. At the same time it is realised that electrification can in itself not address the total energy demand of the poorer sector of the population, as far as the more energy intensive thermal requirements are concerned, necessitating the concept of 'energisation' - widening access to all relevant energy services.

Fossil fuels, such as coal, liquid fuels and gas, and also uranium, play a central role in the socio-economic development of South Africa and consequently sets the tone for the structure of the energy system. The description of the SA energy sector is divided into three sections, SA energy demand sectors, SA energy supply sectors and cross-cutting issues.

2.2 South African energy demand sectors

The total final energy demand of South Africa is depicted in Figure 2.2 and shows that final energy demand is dominated by refined liquid fuels, coal, electricity and traditional biomass, with small amounts of crude oil and gas (Howells, 1999).

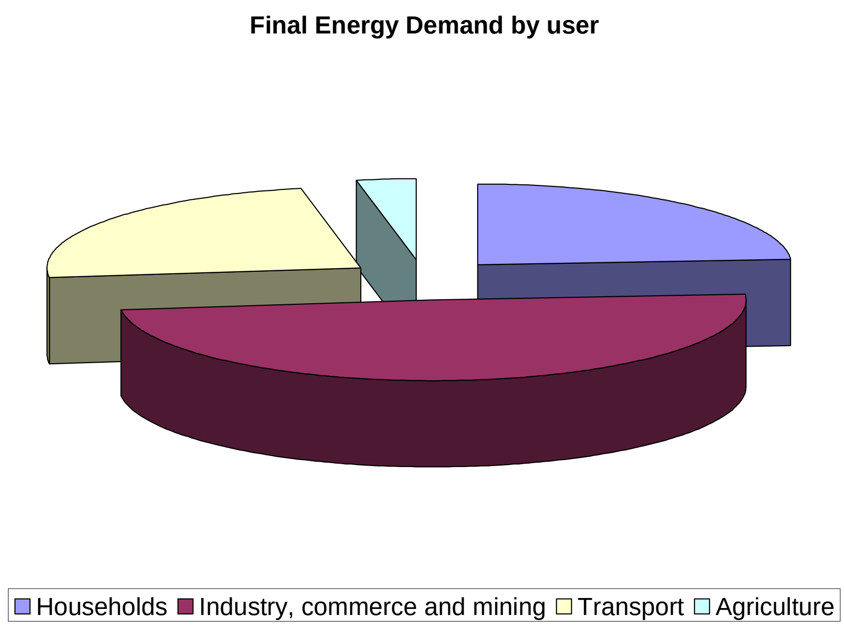

Figure 2.2 *Final Energy Demand by user in South Africa (Source: Howells, 1999)*

South Africa’s energy demand sectors can also be subdivided into various users and are: households; industry, commerce and mines; transport and agriculture. Figure 2-3 shows these users as a percentage of total energy demand.

2.2.1 Households

South African households consume some 24% of the country's energy. By the end of 1997, about 60% of households had access to electricity. Yet this energy source contributed only 20% of household energy consumption. Most energy was obtained from fuel wood (65%). Other fuels used include coal (9%) and illuminating paraffin (8%), and a small amount from liquid petroleum gas (LP Gas) makes up the remainder.

2.2.2 Industry, commerce and mining

Industry, mining and commerce account for about 60% of commercial energy consumption in South Africa, at a cost of approximately R18 billion in 1995. The low price of coal and electricity in South Africa has contributed to the development of an economy with a large energy-intensive primary industrial sector. Mining and minerals beneficiation were responsible for 11% of South Africa's Gross Domestic Product and over 50% of South Africa's foreign exchange earnings in 1995.

2.2.3 Transport

The transportation of people and goods is an essential social and economic service, and accounts for about 24% of total energy consumption. More than 90% of transport energy consumption is derived from liquid fuels.

2.2.4 Agriculture

About three per cent of the total energy used in South Africa is consumed by agriculture, mainly by commercial farmers. Traction and transport tasks dominate this energy use, as evidenced by the fact that liquid fuels meet three-quarters of commercial agriculture's energy requirements. Stationary operations, such as lighting and refrigeration, are generally performed with electricity, although diesel is also used to power pumping and dehulling activities.

2.3 South African energy supply sectors

2.3.1 Electricity

South Africa produced 179 450 GWh of electrical energy in 1997. Ninety-six per cent of this amount is generated by ESKOM and transported over its national transmission network to distributors countrywide. More than 400 distributors, mainly municipal electricity departments, supply electricity to end customers. ESKOM is also the largest single distributor in the country in terms of energy sales for final consumption and number of customers.

2.3.2 Nuclear energy

Nuclear energy is a minor component of the South African energy sector. It contributed about 3% during 1997 of the national primary energy supply, and about 5% of the country's electricity. The main actors in the nuclear sector are the Atomic Energy Corporation (AEC), ESKOM, the Council for Nuclear Safety (CNS) and the private sector Nuclear Fuel Corporation (Nufcor).

2.3.3 Oil : exploration

Despite its generous minerals endowment, South Africa has no significant proven crude oil reserves, but it is believed that potential exists for offshore discoveries of both natural oil and gas and onshore coal-bed methane.

2.3.4 Oil Production and Import

Present crude oil refinery capacity is 455,000 barrels per day with the capacity of the Sasol synthetic fuels plant being 150,000 barrels per day and Mossgas 45,000 barrels per day of crude oil equivalent. About one-third of fuel demand is met by the synthetic fuels industry.

During 1997 South Africa imported approximately 23,6 million tons of crude oil and 21 300 million litres of refined product was consumed. Crude oil is South Africa's single largest import item. Approximately 15% of South Africa's primary energy consumption is currently met by imported crude oil. Taking synthetic fuel production into consideration, liquid fuels meet approximately 28% of South Africa's final energy needs.

2.3.5 Gas

South Africa has relatively small known gas resources of 30 billion cubic metres (bcm) off the south coast and some very small recent discoveries (3 bcm) off the west coast. However, the potential natural gas resources have not yet been fully investigated. To date, South Africa has undertaken limited exploration for oil and natural gas leading to twenty gas and nine oil discoveries. The exploration and exploitation of the Kudu Extension gas field and the Mozambique Pande gas field with its planned pipeline to Sasol in Secunda indicates that gas is going to play an increasingly important role in the energy mix in South Africa.

2.3.6 Coal

South Africa has a coal resource of approximately 121 billion tonnes, of which about 55 billion tonnes are classified as economically recoverable reserves. Although coal's contribution to South Africa's total primary energy supply has declined slowly (approximately 75% during 1997), it still dominates the energy sector. Approximately half the coal consumed in South Africa is used for the generation of electricity, and a quarter for the production of synthetic liquid fuels. A large number of urban households in the central industrialised area still continue to burn coal, even after electrification.

2.3.7 Renewable energy sources

Renewable energy resources provide approximately 10% of South Africa's primary energy. Traditional biomass, in the form of firewood, wood waste, dung, charcoal and bagasse, accounts for close to 10% of net energy use at the national level (60% of household energy consumption). Hydro-electric power contributes less than 1% of electricity generation and most of that is pumped storage. Other renewable energy sources make up a small but increasing proportion of energy supply. These include biogas and landfill gas, which need to be promoted in order to address thermal energy needs.

Although more than 484 000 m^2 of solar water heater panels have been installed, this constitutes less than 1% of the potential market. The government is currently looking at strategies to increase the use of Solar Water Heaters.

The installed capacity of photovoltaic systems is approximately 5 MW_p, of which 50% is used for telecommunications. A total of 280,000 water-pumping windmills are in operation and the installed capacity of small-scale hydropower exceeds 60 MW.

2.4 Reconstruction and Development Programme (RDP)

The RDP programme was the central policy guideline for the new government when taking office in 1994 (ANC, 1994). Its driving force was redistribution of economic benefits and development of the disadvantaged sectors. Targets included land reform; housing, water supply and electrification for currently non-served population; supply of electricity to schools and hospitals, universal access to telecommunications, public transportation systems, nutritional security and public health reform. Special funds and mechanisms were established to implement the programme.

Subchapter 2.7 of the RDP is dedicated to energy and electrification. The driving principle is that energy policy must concentrate on the supply of basic energy needs of poor households, stimulate production and provide energy for community services such as schools, clinics and water supply.

Regarding electricity, the RDP outlined an accelerated electrification programme to provide electricity for an additional 2.5 million households by the year 2000, thereby increasing the electrification level to about 72 per cent of all households (double the number in 1994). Both grid and non-grid power sources were to be employed. All schools and clinics would be electrified.

According to the RDP, the electrification programme would be financed via cross-subsidies from other electricity consumers as far as possible. Where necessary the Government would provide concessionary finance for the electrification of poor households in remote rural areas. A National Electrification Fund was to be created to raise finance from lenders and investors.

As indicated below, the efforts of the new government were concentrated on the drafting, public discussion and release of a new White Paper on Energy Policy, consistent with the RDP, and in enhancing the electrification process already in place by ESKOM. During the last few years the Government has been taking the initial steps to restructure and deregulate the energy sector.

2.5 White Paper on Energy Policy

At the end of 1998 the Government issued the new energy policy through the publication of the White Paper on Energy Policy (DME, 1998). The former white paper was published in 1986 and South Africa’s priority at the time of writing was to secure energy supplies. The change of government brought a shift in the energy policy that needed to be formalised in a new white paper. The revision process commenced with the drafting of a discussion document (Green Paper), released in 1995 for analysis and comment. The resulting Draft White Paper was revised during 1997-1998 and Cabinet approved its release in mid 1998.

The 1998 White Paper is aimed at clarifying government policy regarding the supply and consumption of energy, but it does not attempt to deal with implementation strategies, as they are part of the core functions of the Department of Minerals and Energy (DME). The White Paper is intended for parliamentarians and all involved parties in the energy sector, and is expected to constitute a formal framework for the operation of the energy sector within the broad national strategy.

The policy priorities of the White Paper are summarised below. Issues directly dealing with renewable energy are highlighted **in bold face**.

2.5.1 Energy policy priorities, 1998 White Paper

Table 2.2 *Energy policy priorities (source: 1998 White Paper)*

Objective	Short-term priorities	Medium-term priorities
Increased access to affordable energy services	• Develop electrification policy • **Address off-grid electrification** • **Facilitate management of woodlands** • Establish thermal housing guidelines	• **Stimulate use of new and renewable energy sources** • **Promote improved wood stoves** • Support capacity building, education and information dissemination
Improving energy governance	• Improve government's capacity to govern • Restructure DME's budget • Establish energy policy advisory board • Promulgate electricity regulatory bill • Manage deregulation of oil industry • Establish energy information systems	• Develop research strategy • Restructure state energy assets • Implement new regulation of nuclear energy • **Establish renewable energy database** • Develop institutions to implement energy efficiency programmes
Stimulating economic development	• Encourage black economic empowerment in the energy sector • Manage electric distribution industry restructuring • Restructure the state's energy assets • Remove energy trade barriers and facilitate investment in energy sector • Introduce special levies to fund regulators and other energy agencies	• Introduce competition in electricity market • Establish cost-of-supply approach to electricity pricing • Manage deregulation of liquid fuels industry • Promote energy efficiency • New regulatory system for natural gas • **Develop standards/code-of-practice for renewable energy** • Introduce voluntary appliance labelling
Managing energy-related environmental impacts	• Improve residential air quality • Monitor reduction of candle/paraffin fires resulting from electrification • Introduce safety standards on paraffin stoves • Adopt 'no-regrets' approach to energy-environment decisions	• Develop policy on nuclear waste management • Evaluate clean energy technology • Investigate options for coal discards • Participate in strategies to address climate change • Investigate environmental levy
Securing supply through diversity	• Develop South African Power Pool • Pursue international co-operation • Stimulate energy research • Facilitate regional energy co-operation	• **Utilise integrated resource planning** • Reappraise coal resources and support introduction of other primary energy carriers where appropriate

The White Paper points out that renewable energies are particularly advantageous for remote areas where grid electricity supply is not feasible, and can provide the least cost energy service when social and environmental costs are included.

Following the White Paper, Government should provide focused support for the development, demonstration and applications of renewable energy, and facilitate the sustainable production and management of solar power and non-grid electrification systems, such as:

- solar home systems (SHS),
- wind home systems,
- solar cookers,
- solar pump water supply systems,
- solar systems for schools and clinics,
- solar heating systems for homes,
- hybrid electrification systems, and
- wind mini-grid.

Renewable energy systems should be mainly targeted at rural communities. Government should also promote appropriate standards, guidelines and codes of practice for renewable energy and will establish suitable renewable energy information systems.

The White Paper specifically foresees new joint hydro-power developments for the Cahora Bassa scheme (Mozambique), and similar developments in southern and central Africa.

2.6 Cross-cutting issues

2.6.1 Integrated energy planning

Integrated energy planning (IEP) is a process involving various technical functions to supply and use the information on energy demand and supply required to inform policy development in the South African energy sector. Such capacity does not currently exist within South Africa.

DME has requested proposals from suitably skilled consultants to undertake scenario development and modelling work for the Integrated Energy Planning (IEP) process which is presently underway in South Africa. While the scenario development and modelling work are to be undertaken as discrete parts, they are combined into one appointment to ensure co-ordination between the work areas and in the interests of cost-effective and rapid completion.

The DME has established two working groups to advise the process, as well as an overall IEP Steering Committee. The working groups will be closely involved in the above work as follows:

- Review Group - advise, comment on and guide the Scenario Development component
- Modelling Working Group - advise, comment on and guide the Modelling work.

Two working groups are necessary because the Scenario Development work requires detailed expertise of the energy sector as whole or specific components thereof. The Modelling work requires detailed expertise on different models and their applicability, as well as data availability and limitations. Nevertheless, it is expected that a measure of overlap in functions will occur, and thus close communication between these groups will often be necessary.

The DME has appointed the Mineral and Energy Policy Centre (MEPC) to facilitate the implementation of the IEP, and they will thus be in close contact with working groups as well as the consultants appointed to undertake the above work

2.6.2 Energy efficiency

Since expenditure on energy constitutes a large portion of the country's GDP (15%) and a significantly larger proportion of poor households' expenditure, it is necessary to give attention to the effective and efficient use of energy. Significant scope for improved energy efficiency exists within the industrial, commercial, domestic, and transport demand sectors.

2.6.3 Capacity building, education and information dissemination

South African energy consumers, ranging from low-income households to business and industry, are poorly informed about efficient energy-use practices and options. This lack of consumer knowledge about the efficient use of energy undermines economic competitiveness, the sustainability of development initiatives, the environment and people's health. That education and information can play a central role in addressing these problems is borne out by international experience.

2.6.4 International energy trade and co-operation

South Africa is actively involved in energy trade and co-operation with a number of countries in the region and overseas. Imports include crude oil and energy conversion plants and equipment and exports include coal for international markets and refined liquid fuels for regional markets. Active co-operation with a number of countries and organisations has developed over the years, particularly since 1993, and official participation in Southern African Development Community (SADC) activities commenced in June 1994.

2.6.5 Governance and institutional capacities

At present, parliament and its committees are responsible for energy legislation and the supervision of the executive arm of government. The executive consists of cabinet, the minister and the department, who are together responsible for formulating and implementing energy policy. Appointed boards or councils supervise a range of government-owned energy organisations, some created by means of a specific act, in order to provide them with strategic direction on their operational activities.

2.7 Restructuring of Electricity Generation, Transmission & Distribution Industry

ESKOM is a large and powerful utility, even on a world scale. Its restructuring is part of the broader policy of South Africa to dismantle a number of large parastatals. Specifically, there are several reasons behind the need to reform the power sector. Independent power producers are increasingly interested in entering the local power market, while black economic empowerment has to be boosted and other forms of bulk generation explored.

The Department of Public Enterprises aims to have a competitive market structure in the electricity generation sector by 2004. The first possible phase of restructuring of generation would be the separation of ESKOM's power stations into a number of independent competing generation companies directly owned by the state.

The ministry of Minerals and Energy has initiated the restructuring process for the distribution sector. The White Paper on Energy Policy proposed that ESKOM’s transmission group, which operates the national grid, be separated from the distribution and generation divisions. This process will amalgamate ESKOM's distribution division with the local authority distributors into a number of regional electricity distribution companies (REDs). As an interim step, ESKOM's distribution division would form part of a holding company, EDI Holdings, for the entire distribution industry (see DME, 2000a and DME 2000b).

To prepare ESKOM for this restructuring process, the process of incorporating the ESKOM holding company with a regulated business subsidiary (generation, transmission and distribution) and a non-regulated subsidiary being ESKOM Enterprises, has been embarked on. The formation of a separate generation and transmission company is part of the future design with the final restructuring model for ESKOM having yet to be decided.

With the benefit of a broad restructuring strategy in place, the Department of Minerals and Energy has moved rapidly to get the process underway. A consortium led by Pricewaterhouse-Coopers is technical adviser and had less than a year to come up with an implementation strategy for the restructuring of the electricity distribution industry. The Development Bank of South Africa (DBSA) has been appointed by the DME as project manager for the restructuring initiative.

3. RENEWABLE POWER GENERATION

This Chapter deals with grid-connected power generation, describing its political context, ESKOM's current activities as well as current activities of municipalities and REDs.

Political context

In Europe and other developed countries, environmental concerns provide the main drives for renewable energy development. In South Africa, the interest for renewable energy, is driven by social and economic needs. The ministerial foreword of the Energy White Paper of 1998 describes this clearly (DME, 1998):

> *'As government pursues its macro-economic policy on growth, employment and redistribution, as well as its policy of reconstruction and development, changes take place within the energy sector that continue to present us with interesting challenges. These challenges include the transformation of state-owned entities, the reshaping of governance principles, the enhancement of socio-economic welfare within communities, and even changing people's attitudes towards the use and importance of national energy resources.'*

For understandable reasons, environmental concerns are relatively low on the priority list of the South African government. Cheap electricity helps to attract major industrial activities and thereby boost economic development and job creation. These are the overarching political priorities in South Africa. The negative impact of the use of huge quantities of cheap coal, being used for electricity production, is neglected almost completely. Being the cheapest commercial power source available in South Africa, there is no economical drive to look for alternatives. The main drivers for renewable power generation are therefore formed by:

- economic advantages above centralised production,
- supporting the transformation of state-owned entities, including the reshaping of governance principles,
- increasing the socio-economic welfare within communities

The scarce funding available for subsidy programmes is used in order to support these policy goals. This means that there are no specific financial incentives for renewable energy. **Given that cheap coal is abundantly available in South Africa, it may be concluded that in the current context, there is little scope for grid-connected renewable energy.**

Leaving aside the lack of a financial incentive, there are other political motives driving investment in renewable power. ESKOM provides the following reasons (ESKOM, 2000c):

1. Possible future environmental pressure (health on national level and Kyoto-related on international level.
2. It may be a cost-effective means to meet the challenge of electrification eventually enhanced by climate change-related financing, mainly the CDM).
3. To avoid being forced (by the government) to investigate and finance projects that are initiated outside of ESKOM which from their point of view are not viable.
4. The need for diversification in fuel-input.

Others claim that the ultimate goal of ESKOM in conducting these activities is window-dressing, i.e. showing that they are doing something with renewable energy. Some parties even claim that ESKOM in the end want to de-motivate potential green IPPs and to provide a sound basis for the conclusion that renewable energy is not viable compared to coal-fired plants or the pebble bed reactor.

3.1 Current grid-connected renewable power generation

3.1.1 ESKOM's Sabre-Gen Programme

ESKOM's SABRE-Gen (South African Bulk Renewable Energy – Generation) project is planned to investigate the potential of using renewable energy for bulk electricity generation in South Africa. The program's ultimate objective is to evaluate whether utility scale, renewable electricity generation, is a viable supply-side option for ESKOM and South Africa. The objectives of the programme are:

- Understanding the implications of using renewable energy on a large scale in an African environment.
- Determining the most suitable applications for renewable energy.
- Determining the most appropriate scale of implementation.
- Obtaining all necessary information for the effective implementation of renewable energy.
- Preparing the market and industry for implementation.
- Investigating the sustainability of renewable energy in an African environment.

Demonstration facilities are an integral part of this project. Although it will provide input on all the points raised above, it's primary objective is to prepare the market and industry for renewable energy implementation. In other words, the demonstration facilities are envisaged to provide:

- Demonstrations to the public and other interested parties not currently informed or educated on bulk renewable energy.
- Opportunities for technology transfer, training and practical experience for the industry and potential renewable energy supporting industries and organisations.
- Opportunities to break down barriers to the implementation of renewable energy such as negative social perceptions, non understanding of the technical potential of renewable energy, perceptions that renewable energy is too expensive, etc.

Four energy sources are planned to be investigated, namely wind energy, solar thermal power, biomass and wave energy. Of the four, the Wind and Solar Thermal Electric components are the most advanced, with demonstration projects to be implemented soon. The Solar Thermal Electric component receives support from the GEF. The Biomass and Wave initiatives are still in the early stages of project development, but in all four technology areas it is planned to have demonstration plants running by the year 2005 (ESKOM, 2000b).

3.1.1.1 Wind energy

At present ESKOM conducts three activities: wind resource assessment, feasibility assessment and setting up a pilot/demonstration wind farm (ESKOM, 2000d).

The wind resource assessment is being done on a grid of 75 * 75 km with WASP and 150 * 150 km with CAM (more general). Measurements of weather stations over 4-7 years on 5-minute basis are being used. The main focus is on data related to the coastal provinces, less attention is being given to Gauteng, the inland area and the Northern Cape.

The feasibility assessment is focussed on the development of a pilot / demonstration wind farm. The project is planned to have 4-6 turbines of 750-1500 kW each. Four potential sites have been selected so far and a tendering procedure has been started.

Although the wind resource assessment is being conducted on a rather general scale (with measurements of weather stations), the impression is that there is enough expertise (and contacts with EU-experts) to make a first draft of a South African wind atlas. Further measurements on a more detailed level and with more accurate measuring equipment are necessary on specific sites that are, or will be, identified for establishing wind farms.

In the field of technical feasibility assessment, it is important to realise that up till now there is no experience with establishing and operating larger wind turbines. The only wind turbines presently in operation are in the smaller capacity range (below 100 kW) and for non-grid applications. This means that there is no specific wind energy related expertise in the field of civil engineering, mechanical engineering, electrical engineering (grid connection, grid quality issues like stability of voltage and frequency) and expertise in operating and maintaining wind turbines.

In setting up a pilot / demonstration wind farm, foreign expertise will be essential. This will prevent South African parties from reinventing the wheel. In the first stage, the foreign expertise could be transferred by conducting the implementation process jointly and thus build up capacity in South Africa. At a later stage, the foreign involvement could be reduced to more specific contributions.

Another main issue is the local manufacturing of components or building blocks in South Africa. In the first stage the complete technology could be transferred from Europe or the USA. But at a later stage the manufacturing of towers, the assembly of the turbine or the manufacturing of the blades could offer interesting opportunities for foreign parties as well as for the development of wind energy in South Africa.

3.1.1.2 Solar Thermal Power

ESKOM is involved in a Concentrating Solar Power Project, which is funded through the World Bank/GEF. In this project options have been screened together with NREL (National Renewable Energy Laboratory - USA) and in March 2000 an evaluation was done and a selection made. The following two years will be spent on a full feasibility and it is the intention to build a 100 MW solar thermal demonstration plant by 2004.

Apart from this, several small-scale options will be demonstrated: 2 installations of 10 kW each (of which 1 off-grid) and 1 installation of 25 kW grid-connected, using dish collectors and Stirling engines. There are several European companies involved, e.g. a German company (for Stirling Engines) and a Spanish company (ESKOM, 2000e).

3.1.1.3 Biomass

Work on the biomass project only started during the first half of 2000. An interesting possibility seems to be the introduction of fast growing crops. This is being looked at initially in the Eastern Cape (where there are severe erosion problems) and then subsequently on national level. Crop growing for material and energy production fits in with the central policy aims of the government: job-creation.

ESKOM’s plans for this area of technology cover the following (ESKOM, 2000f):

1. identification of biomass streams that are not used at the moment and the development of cash crop farming,
2. technology identification and ranking (including South African developments).

3.1.1.4 Wave energy

At the moment ESKOM is making an inventory of different technologies available and evaluating these concepts. One option that they are looking at is a development in the USA (Jersey) where a wave-breaker system is being developed which takes about 95% of the energy out of the waves. A 2 MW first of a kind unit is being planned in the USA. Another option is the 1MW device developed in Scotland and now in operation on Islay (Off-shore Scotland).

Although a lot of activities related to wave energy are going on world wide, most of the technology is far less mature than e.g. biomass technology or wind energy. South Africa doesn't have any experience with wave energy, but the available wave resources offer a large potential for this technology (ESKOM, 2000g).

3.1.2 Other ESKOM renewable energy projects

ESKOM inherited four small hydro power plants in the present Eastern Cape Province from the Transkei government when the homeland governments were dissolved and integrated into the South African government in 1994. These hydro power plants, described below in Table 3.1, are connected to the national transmission network and are providing base load to the ESKOM system (NER, 2000a).

Table 3.1 *ESKOM small hydro plants (NER, 2000a)*

Name	Licensed Capacity [MW]	Maximum power produced [MW]	Net energy sent out [MWh]	Private consumption [MWh]	Load factor [%]
Collywobbles	42	42	257 544	0	70
First Falls	6	6	36 792	0	70
Second Falls	11	11	67 452	0	70
Ncora	2	2	12 264	0	70

3.1.3 Renewable power generation by IPPs and REDs

Besides, ESKOM's projects there are a few renewable IPPS operating in South Africa with a license from the NER. The National Electricity Regulator has licensed 8 renewable energy based non-ESKOM operated power plants. Of these 4 are bagasse burning sugar mills, 3 are municipal owned hydro power plants and one is a privately owned small hydro power station. The current overview is based on NER (2000a).

3.1.3.1 Private-owned small hydro-power

Friedenheim hydro

Friedenheim hydro can be viewed as the only existing IPP in South Africa. It is privately owned, sells the bulk of the generated electricity through a Power Purchase Agreement (PPA) and is a profitable operation. The plant is operated as a commercially profitable and sustainable business venture. It was financed through equity provided by investors (Friedenheim Irrigation Board - FIB).

The small hydro power plant is situated next to the town of Nelspruit in the Mpumalanga province. It is owned by the members of Friedenheim Irrigation Board and operated by MBB an engineering firm. The plant provides power for water pumping to FIB, but 93% of the power generated is sold to the Nelspruit local authority through a PPA that sets the tariff at 12% below the price at which Nelspruit buys power from ESKOM (its bulk electricity provider).

The Friedenheim Hydro scheme has proved a profitable and viable investment. Its successful track record has gone along way towards dispelling the myths common in the electricity supply industry that it is impossible to compete with ESKOM, especially with small and renewable energy producers selling energy wholesale.

The motivation for the PPA with the Neslpruit Local Authority was based on the cost savings involved in buying electricity at a rate below that of ESKOM and to a lesser extent the increased security of supply offered through this diversification in suppliers.

Municipal owned hydro power stations

Three small municipalities are currently licensed to operate small hydro power stations. These stations date from the 1930's, and although these plants can be expected to operate for many more years operating efficiencies are decreasing. This is evident from the low load factors, which are at best half that experienced at the more modern Friedenheim plant. This implies that the plants were in full-scale operation for only some 50% of the year. An overview of the plants are provided in Table 3.2.

Table 3.2 *Municipal small hydro power plants*

Name	Licensed Capacity [MW]	Maximum power produced [MW]	Net energy sent out [MWh]	Private con-sumption [MWh]	Load factor [%]
Lydenburg	2	2	6 000	0	34.2
Ceres	1	1	413	0	8.6
Piet Retief	1	1	2 900	0	33.1

Lydenburg

The hydro station in Lydenburg, which dates from the 1930's, has been out of operation since 1998. This was due to the need to repair components of the power plants as well as the connector to the town's distribution system. The Town council therefore decided to subcontract the operation and maintenance of the plant to the private sector. The intention is that the plant will be leased to a private operator who will do the necessary rehabilitation and sell the electricity to the town. This will in effect make Lydenburg Hydro an IPP. Some five companies responded to the invitation to tender. At the time of writing the result of the tender has not yet been announced.

Ceres

The Ceres hydro station has a nominal capacity of 1MW. The maximum demand from Ceres varies between a minimum of 6000kVA and 14000kVA. Electricity is generated between a minimum of 50kVA and 900kVA or between 0.35% and 15% of the total usage by Ceres. The amount of electricity generated is determined by the amount of water available in the dam. The generation of the power from the station represents an annual saving of 2.5% on the electricity account at current ESKOM tariffs.

Piet Retief

The Bakenkop hydro power plant was commissioned in 1950 to supply the town of Piet Retief with electricity before it was connected to the national transmission system. After 50 years it is still providing power to the town. The installed capacity is 0.8 MW. The system operates intermittently depending on the availability of water. The annual operational cost is R 290 760. There is no foreseen upgrading or decommissioning of the plant. At present it provides electricity at an average cost of R 0.09/kWh which is about half the rate the town pays to ESKOM for its power. The 1998 load factor of 33% will result in revenues of R 210 000, which are some R 90 000 less than the operational costs, and the plant is therefore running at a loss. The power station is clearly very maintenance intense.

Cape Town Pumped Storage

The City of Cape Town owns and operates the 180 MW Steenbras pumped storage power station for peak power production. This is however not a renewable energy generator as the plant uses electricity purchased from the national transmission system (i.e. coal based electricity) to pump the water during off peak times.

3.1.3.2 The sugar industry

The sugar industry is the biggest and best-established example of renewable energy fuelled non-utility generators in South Africa. There are 15 sugar mills in South Africa of which five have been licensed as electricity generators by the NER. All the plants generate steam and power from bagasse. The licensed plants are those which are in a position to export power as listed below in Table 3.3. The unlicensed plants are therefore not exporting any power.

Table 3.3 *Sugar mills licensed by the NER*

Name	Licensed Capacity [MW]	Maximum power produced [MW]	Net energy sent out [MWh]	Private consumption [MWh]	Load factor [%]
TH Amatikulu	12	10	43 775	43 775	51
TH Darnall	13	7	27 388	27 388	44.7
TH Felixton	32	22	79 935	79 935	41.5
TH Maidstone*	29	20	79 582	44 917	45.4
Transvaal Suiker**	20	-	-	-	-

* The Tongaat Hulett Maidstone is a combined bagasse/coal plant

** Transvaal Suiker was awarded a generation license in June 1998 and no data is available at present

3.1.3.3 The wood and pulp industries

The industry consists of two sectors, the production of timber and the production of wood pulp for paper and board manufacture. A large proportion of the output of softwood mills in South Africa is in the form of kiln-dried timber resulting in a great demand for thermal energy. Almost all of these mills use their wood wastes as boiler fuel for steam generation while some also practice cogeneration. Most of the wood mills only utilise the steam generated and still buy their electricity from the local distributor - usually ESKOM. Only three of the South African mills generate their own electricity.

A reason why only steam is produced is that kiln heating steam is required round the clock but electricity is only required for the 10-12hours/day of the sawmill's operation. For the sawmills to generate power it must be possible to sell this surplus power when the mill is not operating. The electricity generation potential through co-generation technology is about two to three times the mill's own demand.

Steam is produced in the sawmills by the combustion of the wood wastes that result from the timber production process. Saw mill waste makes up about 34% of the tree as harvested.

In all three cases, where South African saw mills are producing electricity, the electricity is generated though the use of steam condensing turbines. These turbines were invariably purchased second hand from small municipal power stations.

The saw milling industry is well aware of the potential for co-generation power production. This potential is not realised due to the competitive tariffs offered by ESKOM and the high cost of installing new power generation equipment.

The pulp and paper mills generate some power for their internal needs. This is mostly due to the need for reliability in electricity supply during production. A dip in power supply can have serious effects on production. Power is derived from burning waste wood bark in combination with coal and the distillate from wood chips (black liquor). The energy recovery from black liquor and bark is typically a third of that which is found in similar plants in Scandinavia. There is only one recorded case of a South African mill burning bark for power generation.

There is therefore potential for upgrading of these plants to provide more heat and power. The availability of the resource cannot be seen as the constraint rather the financial viability of converting the plants into power exporters and selling electricity into the available market.

Table 3.4 below lists the wood and paper mills in South Africa that process wood for paper production. There are a number of other mills in South Africa that produce paper but these do not process wood as pulp source and therefore doe not have power generating capacity.

Table 3.4 *Pulp and paper mills in South Africa*

Name	Number of mills
Mondi Group	6
Sappi Group	7

The fact that none of the wood or paper mills are licensed by the NER is an indication that no power is currently exported from these mills compared to the licensed bagasse plants. The mills are opting to buy power from ESKOM and to utilise their own generation capacity for increased security of supply. This is a good indication of the perception within the industry of the economic value of own power production. At present bulk electricity prices, the mills do not see themselves competing with ESKOM. The mills will have to more than double their energy production in order to meet own demand and have power available for export.

3.2 Barriers

The above overview illustrates that the renewable power generation market is still underdeveloped. ESKOM's initiatives are still in their early phase and have explicitly an investigative and demonstrative character, they do not intend to put up a full-blown renewable power programme. With regard to IPPs, only a few licences have been awarded for relative small installations (around six, based on the above overview).

The conclusion that the IPP market is underdeveloped also stems from our analysis of policy environment. Currently there is no favourable market environment for large-scale penetration of grid-connected renewables. Major changes need to occur before that is going to happen.
There are three main policy issues related to IPPs:

- economic and financial viability,
- ESI restructuring,
- institutional and legislative framework.

3.2.1 Economic and financial viability

Environmental concerns in themselves often represent economic values, such as avoided health costs, opportunity costs for depleting the countries stock of fossil fuel energy and benefits of preserving natural resources for future generations. Apart from the environmental costs, subsidies which were provided to coal electricity have to be included in cost pricing. These external costs and benefits are not reflected in present accounting methods for ESKOM's electricity. In analysing the viability of renewables in South Africa, a case based on the current situation (financial viability) should be prepared, this should then be compared to a case which includes estimates of external costs (economic viability).

Financial viability of renewable IPPs

Because of its decentralised nature, renewable power can offer electricity directly to its customer, the local distribution utility or a big consumer. Renewable power can therefor avoid the expensive transmission costs associated with conventional grid electricity.. The renewable IPPs costs for production would have to be below this wholesale tariff in order to be competitive with ESKOM's power.

The wholesale price of ESKOM power varies greatly depending on geography and scale of the utility. For illustrative purposes we will take the Cape Town Metropolitan Council, which pays at this moment on average 12,5 - 13,5 Rand cents per kWh, of which app. 8-9 Rand cents per kWh can be attributed to transmission costs. If the transmission costs are deducted and the remaining price is compared to typical generation prices of renewables (Table 3.5), it is clear that this price is hardly competitive for any renewables, except in certain cases for micro-hydro power or the use of biomass waste.

Table 3.5 provides an overview of renewable generation costs. It should be borne in mind that the real price of renewables are very site-specific, because they are highly influenced by local resource availability, accessibility of the site, existing power infrastructure, etc.

Table 3.5 *Overview of typical ranges of renewable generation costs*

Renewable Energy Technology	Production costs [Rand cents per kWh]
Wind	30 - 45
Solar Thermal Power	App. 40
Biomass	10 - 50
Hydro	10 - 50

Economic viability of renewables

When economic viability is taken into costs, not only the financial costs are considered, but also the hidden costs of each options. These hidden costs consists of two components: subsidies and environmental costs.

ESKOM claims the electricity generation costs to be 3-5 Rand cents per kWh. These low costs reflect the low fuel prices (cheap coal, abundantly available), but they also reflect the fact that a large part of the capital costs are not included in the cost price calculation. It should be expected that ESKOM's generation costs will rise substantially once new investments have to be done and the capital costs have to be included. Due to increase in demand and age of a number of coal-fired power plants. the current situation of over-capacity in electricity generation is expected to end by 2008. New plants will have to be built by the year 2008 and onwards. Based on prices of new coal power stations in Europe, it is assumed that the investment costs will be around 10 Rand cents, of which 50% are required for end-of-pipe measures.

The same applies for transmission costs. ESKOM's coverage for transmission is now around 8 Rand cent per kWh. Once ESKOM is privatised, transmission is likely to be owned by a state-owned monopoly who will charge the private users of its network with real costs in order to make up for new investments in the transmission grid. In the case of South Africa, these costs can be particularly high, considering the long transmission distances involved.

Incorporating environmental pollution

Local environmental problems, such as acid rain, soot particles, etc. have severe local health impacts. It is difficult to make exact economic estimates of such health impacts. Therefore we take as a reference the opportunity costs of avoiding such emissions, i.e. the costs end-of-pipe measures.

With regard to global environmental pollution, i.e. greenhouse gas emissions, the same method can be applied and an international carbon reference price can be taken as a shadow price to estimate the benefits of avoided carbon emissions. Estimates show that if a carbon price of US$8 per tCO_2 is taken, this amounts to Rands 0,07 per kWh.

Table 3.6 provides a summary of the economic costs of current electricity production in South Africa[3]. It shows clearly that if the economic benefits are taken into account the viability gap may be reduced to 6 Rand cents/kWh. If the Government of South Africa were to install a renewables financial support mechanism including a shadow price for renewable generation of around 23 Rand cents/kWh and an international carbon credit trading system be in place, providing at least 7 Rand cents per kWh (DANCED, 2001), it is evident that renewables are far much closer to financial viability than in the current situation. As the examples in the previous section shows, local opportunities may benefit from these returns.

On basis of the present viability gap, it may be concluded that financial incentives, subsidies, or marketing of green electricity will be much less effective as long as investment costs are not included in the calculation of the production costs.

Table 3.6 *Economic benefits of renewables in South Africa*

Economic costs	Current costs [Cents/kWh]	Economic costs [Cents/kWh]
ESKOM's avoided generation costs	0.05	0.05
Investment costs		0.05
Transmission costs	0.08	0.08
Sub total of capital costs	0.13	0.18
Avoided end-of-pipe measures		0.05
Avoided global carbon costs		0.07
Sub total including capital and environmental costs	0.13	0.30
Gap	0.23	0.06
Renewable power alternative	0.36	0.36

3.2.2 Restructuring ESKOM and the municipal distribution companies

The South African Government is currently considering implementing reform initiatives in both the Electricity Distribution Industry (EDI) and the Electricity Supply Industry (ESI) of South Africa. Reform of the EDI is being initiated primarily because the industry is fragmented, with many distributors not being financially viable. ESI reform follows international trends whereby competition and greater private sector participation is being called for. These two processes are likely to proceed simultaneously, though it seems reasonable to assume that ESI reform initiatives will take longer to implement - especially if *all* customers are eventually granted choice of power supply.

3 It should be borne in mind that these figures are based on rough expert assumptions. Nevertheless, we believe that the real figures would be in the proxy of these figures.

The South African Government believes that EDI reform should be undertaken in order to:

- ensure electrification plans are implemented,
- provide low-cost electricity,
- facilitate better price equality,
- improve the financial health of the industry,
- improve quality of service and supply,
- foster proper co-ordination of operations and investment capital, and
- attract, and retain, competent employees.

To address these concerns, Government now plans to consolidate the EDI into a maximum number of financially viable independent regional electricity distributors (REDs). Government's appointed technical advisors of this particular initiative, PriceWaterhouseCoopers, recently released a working paper (Energize, 2000) detailing views that have emerged following extensive (yet ongoing) analysis and various stakeholder meetings.

As a first step in the restructuring of the electricity industry, the Government plans to corporatise ESKOM, subjecting it to taxation and dividends withdrawal. To this end, the ESKOM Amendment Act has been passed by Parliament but its implementation has been postponed by the Government. In the long term ESKOM would be divided into separate generation. transmission and distribution companies.

Besides ESKOM, around 400 municipalities distribute electricity, most of them buying it in bulk from ESKOM. A reduced number of municipalities also operate their own power plants. The municipal distributors are represented by the Amalgamated Municipal Electricity Undertakings (AMEU). As part of the restructuring process, the distribution part will be divided in six regional Electricity Distributors. The shares of the REDs will be owned by the local and national government (the national government taking on ESKOM's assets).

Due to the policy of transformation of state-owned entities and the reshaping of governance principles, there will be room for IPPs to enter the market in the near future, but apart from some existing smaller entities, the first one still has to be established. This first IPP is facing a lot of organisational and juridical troubles, but will in the end probably pave the way for other initiatives.

Therefore it may be concluded that rationalisation of the EDI will not in itself impact considerably on the fate of renewable energy generation in South Africa. It provides however an essential step towards a better environment for IPPs because ESI reform initiatives assume a maximum number of financially viable REDs operating in a more competitive environment, and one in which there is ultimately more private sector participation.

The following impacts of the rationalisation process on the position of IPPs can be distinguished:

- It is likely that under the reformed REDs a different tariff structure for wholesale electricity delivery will apply. Wholesale prices will be more dependent on the time of consumption (peak demand versus low demand). This will make local generation more favourable. This tariff reform is expected to take place within two years. First signs are already noticeable: ESKOM is operating at this moment an internal power pool in order to stimulate competition and to gain experience.
- At this moment there is a proposal that an RED may not own more than 50 MW of embedded power generation capacity in order to control peak load power demand. The remaining peak load will have to be bought on the market. It is still unclear when this restructuring process will be finished, but according to the general opinion, this may take up to five years.

3.2.3 IPP regulatory framework

There are three main issues with regard to the regulatory framework for IPPs:

- the possibility of a long-term PPA,
- the role of the National Electricity Regulator,
- open access to the National Transmission System.

Long-term PPA

An important issue for private investors is the possibility of negotiating a long-term PPA. In the present environment, securing a PPA is critical to the success of IPPs. A long-term PPA is essential for obtaining commercial financing for the project. Unfortunately NER has stated that it will not approve applications for generation license involving long-term PPA. Since NER requires such license for generation above 5 GWh/year, this stance is a very critical barrier. One of the reasons for NER's stance is the perceived risk of allowing competition too early in the restructuring process. The lack of long-term PPAs resulting from NER's stance makes it very difficult for the developers to secure debt for their projects. The alternative, financing only with equity, is usually not practical.

Larger banks in South African have divisions specialised in financing of projects, capable of dealing with IPPs. Issues to be secured are mainly:

- commercial viability
- scale of the debt component
- long-term PPA
- credit ranking of the purchaser
- stable regulatory and policy environment
- risk sharing with equity holder

IPPs are perceived as risky by the banking sector. This leads to higher interest rates and selective financing to most secure and profitable projects. The debt component should be R30 million and over; assuming a debt/equity ratio of 50/50 the minimum project size is around 10 MW. The above implies financial barriers, especially for less profitable or smaller projects.

The role of the National Electricity Regulator

IPPs will have to arrange their contracts with the National Electricity Regulator. At this moment the NER is opposing contracts with clients or with IPPs for longer than 5 years. Current plans are to allow big consumers (over 100 MW) buying their electricity from any supplier nation wide.

The White Paper on Energy Policy (WPEP) notes that IPPs will be allowed to enter the electricity market, but that full competition will not occur until distribution sector restructuring and electrification is completed (DME, 1998). In the interim period before the advent of full competition the WPEP envisages ESKOM's transmission business publishing 'approved tariffs for the purchase of co-generation and independently generated electricity on the basis of full avoided costs'. This establishes a situation where IPPs and co-generators act as contractors to ESKOM in meeting customer's electricity needs, but do not compete openly with ESKOM.

The WPEP requires the NER to approve the tariffs paid by ESKOM Transmission to IPPs and co-generators. An important consideration will be whether the tariff arrangements proposed by ESKOM adequately reflect the full avoided costs of purchasing electricity from IPPs and whether they are sufficient to encourage the entrance of new players. The NER will also be required to issue licenses to these new players and to make the necessary amendments to ESKOM's licences. Licences will stipulate for how long the proposed tariff arrangements will last and to whom IPPs are allowed to sell during the interim period.

Potential IPP investors need to assess their likely returns over the economic life of their investment. Therefore the NER is also likely to be required to give some consideration to the regulatory arrangements which will be put in place as more open competition in the generation market is introduced.

Open access to the National Transmission System
The WPEP recognises that open non-discriminatory access to the transmission lines is a prerequisite for open competition in the generation market. This requires the NER to ensure that neither the technical terms on which access is provided, the access charging levels, nor the method of calculating use of the transmission system forms a barrier to entry for independent generators. In this field a lot of arrangements still have to be made.

3.3 Support for renewables within the restructuring process

It can be concluded that the short term perspectives for IPPs in general and more specifically for green IPPs are not very positive. The unclear organisational and legislative framework, the ongoing restructuring of the electricity market and the competitiveness with the existing generating capacity are the main barriers.

It can also be concluded that the policy focus in South Africa is currently on the restructuring of the ESI, a time consuming process expected to take another 4-5 years, which will establish the framework for IPPs competing with ESKOM. The current regulations for green renewable IPPs are very unattractive and it is unlikely that they will be addressed prior to the set up of the IPP framework under the ESI restructuring. Hence, a more sustainable market environment for green renewable IPPs is likely to wait another 4 to 5 years.

Currently the electricity sector in South Africa is dominated by ESKOM, the parastatal utility, as it is by far the largest generator, owns the national transmission network and is the single largest distributor. In the presence of this de facto monopoly, IPPs in general and renewable IPPs in particular have at present extremely limited opportunities to enter in the electricity market. Very few independent generators are currently operating. Those that are, were set up in very special circumstances and not as a result of an intentional IPP development.

This situation may gradually change in the future since both the electricity supply and distribution industries are to be restructured. The reform of the ESI, most relevant for IPPs, aims at opening the current monopoly to competition and private sector participation.

Restructuring of the ESI is a specific mandate of the 1998 White Paper on the Energy Policy (WPEP) and is the basis of the current South African energy policy. The model to follow is still being debated. Some recent indications are that ESKOM would be corporatised into separate transmission, distribution and generation entities, and that separate generating companies would be formed to promote internal competition prior to the introduction of private sector participation, the latter aimed at providing new power requirements.

A functional framework for IPPs resulting from the restructuring process will be necessary. This may not be sufficient to encourage new renewable IPPs. These generators will be at an inherent disadvantage to conventional IPPs. Special provisions should be introduced in the framework to have renewable IPPs competing on a level playground. The imminent restructuring of the South African electricity sector offers the unique opportunity to build renewable-friendly provisions into the new framework.

3.4 Opportunities for further actions

3.4.1 Policy related activities

From the previous sections it is readily seen that regarding grid-connected renewable generation, the WPEP and the Implementation Strategy for Renewable Energy (ISRE) emphasis is on the assessment of resources and technologies (DME, 2000e). The political priority is rather the deployment of off-grid renewables, as the energy supply to disadvantaged sectors. However, the greater part of renewable resources can only be tapped through on-grid generation. This potential has not been fully addressed at the political and governmental levels.

It is important to note that since 1998 DME and an EU party, the Danish Co-operation for Environment and Development (DANCED), have taken steps to support bulk wind energy generation in South Africa, using the Darling Wind Farm as a pilot project. Studies for the development of the farm would be financed by DANCED and the United Nations Development Programme (UNDP), with some of the funds coming from the Global Environment Facility (GEF).

The first step was to carry out research on independent bulk power production with renewable energy sources. The initial results were discussed with relevant stakeholders in September 2000. The DME/DANCED study, released in January 2001, presents recommendations to DME and NER on the way forward (DANCED, 2001).

The South African needs for support are elaborated upon in the next paragraphs, providing an overview of potential opportunities for further actions. Being based upon the DME/DANCED study, it is recommended that any new initiatives of co-operation in this field should be coordinated between DME, DANCED, other interested EU parties and South African stakeholders.

- *Development of a set-aside programme*

The concept is to reserve a fraction of the total power demand (an initial block of 200 MW is being proposed in the DME/DANCED study) to the most competitive renewable energy producers. The distribution companies would be obliged to purchase the renewable power at premium prices.

Expertise would be required to assist DME and NER in designing the pilot phase of the set-aside and fitting it in the ESI and EDI restructuring processes. Interested developers and investors would also need assistance to participate in the selection process and then in the development of the IPPs.

Potential foreign collaboration for the above may be requested from implementing bodies of countries already well experienced on set-aside programmes, notably the Department of Trade and Industry in the UK, responsible for the Non-fossil Fuel Obligation (NFFO). Foreign developers and investors participating in the national set-aside programmes could also be linked to their counterparts in South Africa, in order to develop collaboration and partnerships.

- *Power purchase regulation*

Renewable IPPs and utilities have conflicting views on the value of the power to be transacted, so the purchase needs to be regulated by an independent body (e.g. NER). An interim regulation is proposed from the beginning of the set-aside programme, to be later amended to encourage renewable IPPs beyond the set-aside.

Some expertise is needed to help the power purchase regulator in developing key issues (e.g. determination of avoided costs, compensation for externalities etc).

- *Integrated resource planning*

The WPEP requires the implementation of Integrated Resource Planning (IRP) in the ESI. IRP entails formulating plans to meet the country's future electricity needs at the lowest possible cost. Grid-connected renewables should be properly considered among the alternatives to conventional power supply, in order to ensure the gradual incorporation of the renewable potential in the energy system.

Expertise is required at DME and NER to include renewables in the modelling and forecasting procedures that will produce data for the IRP exercise.

- *Tariff structure*

The WPEP states that tariffs for IPPs should consider full avoided costs; furthermore, it notes that environmental costs should be included in order to promote renewable generation. Along with power purchasing agreements, tariffs are the most important issue for making renewable IPPs viable beyond the set-asides.

Expertise is needed to design a tariff structure that promotes competition and efficiency, and at the same time considers the inherent disadvantages of renewables, especially environmental externalities.

- *Innovative financing*

Renewable IPPs face much more expensive finance compared to conventional utilities. Expertise is required to assess the real risks of lending to renewable IPPs and to develop innovative finance packages addressing the particular characteristics of renewable grid generation, e.g. equity and debt capital, risk guarantee schemes, etc.

Most EU countries are familiar with specialised financing for renewables. Implementation bodies in these countries may be in the position to collaborate with South African parties in the development of appropriate financial mechanisms.

- *Green power marketing*

Demand for green energy is slowly emerging in South Africa, initially from companies seeking to provide environmentally friendly products in foreign markets. Such demand should be linked to renewable IPPs as a way of covering their incremental costs.

Expertise is required to design the green energy option within the regulatory framework. Initially the regulator would approve the green tariff in a case by case basis. A market-based approach could be developed in a later stage, e.g. through green certificates.

Different EU countries are involved in green investment funds, tariffs and/or certificates (e.g. Denmark, Belgium, Germany, Italy, Finland, Sweden and the UK). Some of this experience may be used to assist South African parties as required.

- *Capacity building*

The upcoming restructuring process of the electricity sector will be very demanding for DME and NER, especially if the development of grid-connected renewables is to be integrated in the process. Both institutions feel that their capacity on renewables should be further developed.

Additional support for the implementation of grid-connected renewables may be obtained from other EU parties with relevant experience.

3.4.2 Demonstration projects

3.4.2.1 Wind energy

- *Wind measurements*

Wind measurements on a more detailed level and with more accurate measuring equipment are necessary on specific sites that are or will be identified for establishing wind farms.

- *Capacity building in the field of technical feasibility assessment*

Foreign experts could offer an important contribution in assisting the technical feasibility assessment, but even more in building up expertise in South Africa.

- *Implementation capacity*

In setting up a pilot/demonstration wind farm, foreign expertise will be essential. The involvement of foreign experts will prevent South African parties reinventing the wheel. To start with, foreign expertise could be transferred by conducting the implementation process jointly and thus build up capacity in South Africa. At a later stage, foreign involvement could be reduced to more specific contributions.

- *Local manufacturing*

Another important issue is that of local manufacturing of components or building blocks in South Africa. Initially the complete technology could be transferred from Europe or the USA. But at a later stage, the manufacturing of towers, the assembly of the turbine or the manufacturing of the blades could offer interesting opportunities for foreign parties as well as for the development of wind energy in South Africa.

3.4.2.2 Solar Thermal Power

- *Transfer of knowledge and experience with development and implementation*

The main South African demand in this field is knowledge of and experience with the development and implementation of specific technologies. An inventory of companies that are actively involved in projects that have been implemented in the EU, could provide a useful base for further co-operation.

3.4.2.3 Biomass

- *Developing a roadmap*

The diverse biomass resources, the different available technologies and the numerous possible applications make it hard to get a proper overview of the most interesting opportunities. In Europe different studies have been conducted in which an inventory of all resources, technologies and applications is made and analysed in order to develop a roadmap on which further actions can be based. Apart from a methodology, many characteristics and data have been gathered in order to create such a roadmap. This experience could assist South Africa in creating a similar road map. The main focus would be on

- screening available technologies on their applicability and characterising them in technical and economical terms,
- conducting a resource assessment in terms of quantity and quality of available biomass,
- comparing the export of foreign technology and possible manufacturing of this technology in South Africa to own technology.

3.4.2.4 Wave energy

- *Working out a business plan for an international wave energy testing site*

Given the priorities in South African energy policy it is not advisable that South Africa become involved in basic research on this topic. An attractive opportunity for South Africa would be to establish an international wave energy testing site at which developers of different technologies could test and further develop there technology. Such a site, taking advantage of the good wave regime at the South African coast, probably could be co-financed by the parties involved in wave energy R&D. The establishment of such a test site would offer opportunities for South Africa to get involved in wave energy, but could also boost the development of wave energy technology world wide.

A first step would be to work out a business plan together with interested foreign parties involved in wave energy developments.

3.4.3 Commercial project opportunities

Despite the current unfavourable environment to the development of IPPs, especially renewable ones, there are niche markets where particular conditions can eventually make renewable IPPs viable and competitive. The more promising opportunities in these markets appear to be mini-hydro plants, wind turbines and renewable generation in the sugar, wood and pulp industries.

3.4.3.1 Mini-hydro projects

The hydropower potential of South Africa is concentrated along the eastern escarpment, especially in the Eastern Cape Province, with up to 8000 potential sites. Given the high variability of the flow patterns along the year, most of them would require storage. Due to the negative environmental and social impacts of large dams, some international organisations (e.g. the EU) only consider renewable plants below 10 to 15 MW, a limit to bear in mind within the present study.

A study sponsored by the European Commission in the Eastern Cape (CSIR et al., 2000) showed for example that sites with higher potential (0,8 t0 10 MW) are located on the Kraai River (north east), and on the Sondags and Groot Vis rivers (southern coastal area).

The above and similar studies contain portfolios of projects that could be further investigated by South African and EU parties. This could be done within the scoping study on small hydropower systems being proposed by the DME within Action 6 of the ISRE. An initial contact with EU developers through the European Small Hydropower Association (ESHEA) may be appropriate.

It is worth mentioning that one mini-hydro IPP is already being developed by South African and EU parties. The IPP is called Bethlehem Hydro (see Box 2) and is one of the four applicants to the NER for renewable generation as of December 2000. The company intends to implement the project under a BOO (Build, Own, Operate) scheme. Some potential shareholders and equity partners are EU companies, namely Cinergy Global Power Ltd (UK), Electricité de France (EDF) and eventually NUON (Netherlands). Part of the additional costs are to be covered by environmental concessionary finance via the AIJ (Activities Implemented Jointly) Programme of the Dutch Government.

Box 2 - Bethlehem Hydro

- Mini Hydro Power project of 9,81 MW. (1.05 MW, 3.7 MW and 5,06 MW).
- All the plants within an acceptable range of a major rural town. The town(s) will be the major base client(s) for the plant(s).
- Two plants to be constructed on the Axle River close to the town of Bethlehem.
- Of these plants one at an existing dam wall with a head of 10-12 m, the other at a drop in the Axle River of approximately 40 m. The long-term water resource in the Axle River amounts to some 12 m^3/s.

Economics:

- Total cost estimate R 65 million complete.
- Approx. 8-10 year payback at 13 c/kWh and interest rate of 16%.
- Present average yearly electricity price for town is 14,6 c/kWh.
- Estimated rate of return on equity after taxes is +20 % based on pre-feasibility
- Avoided CO_2 emissions approx. 64.000 tons/CO_2/year.
- Cost per ton CO_2 mitigated (based on AIJ-finance) is approximately US$8/ ton CO_2 (depreciated in 1 year) or US$0.43/ ton CO_2 (depreciated over lifetime)

Project Status

- Project identification and pre-feasibility completed.
- Project development team secured. Intent to purchase obtained from base client. Discussions ongoing with Town Council re. Power Purchase.
- Detailed feasibility study required.
- Pending feasibility study outcome, project development to be completed.
- Project participants identified, IPP Company established. Commitments from stakeholders secured.
- Concession to generate power applied for from National Government. In principle approval obtained
- Tentative permit to utilise water resource applied for and received.
- Financing for feasibility study to be secured.
- Pending study outcome bulk financing, equity partners and investors to be finalised.

Source: DANCED (2001)

3.4.3.2 Wind power

Wind resource is good along most of the South African coast with specific locations offering higher potential (mean annual speeds above 6 m/s and power exceeding 200 W/m2). Moderate wind power is found in the Eastern Highveld Plateau, Bushmanland, Eastern Cape and KwaZulu-Natal.

A detailed regional assessment was made in the Eastern Cape Province, as part of the above mentioned EU-sponsored study (CSIR et al., 2000). The coastal areas show good potential, especially around Cape Recife, Patensie and Uitenhage. Moderate potential exists on the inland coastal plain. The mountains around Fort Beaufort, Graaf Reinet and Jamestown show a slightly better potential. Following this assessment, site-specific studies in the most promising areas are needed to identify new projects.

Action 6 of the ISRE foresees the development of a national plan for wind power, and the support to three demonstration wind farms. As indicated in Box 1 above, one of these farms (Darling) may receive assistance from DANCED for its preparation. EU parties have already collaborated with the promoter of the farm, i.e. the wind turbine manufacturers AN Windenergie

GmbH (Germany) and Bonus Energy A/S (Denmark). Collaboration from other EU parties may be possible, both in the present project (5 MW) and in its eventual extension.

The other two projects to be supported within DME's national wind power plan (Strandfontein and Kanonkrop) may also be open for collaboration of EU parties.

Further opportunities exist in a longer term for the development of new projects in areas of major potential, for example in the Eastern Cape Province. The resulting new initiatives should be linked to DME's national wind power plan, in order to take advantage of the benefits it may offer (e.g. promotion of wind IPPs and links to international funding).

3.4.3.3 Sugar industry

Fifteen sugar mills operate in South Africa and cogenerate steam and power from bagasse (one of them used also coal). Only five plants are currently in a position to export power as indicated below.

Table 3.7 *Sugar mills exporting power*

Name	Licensed Capacity [MW]	Maximum power produced [MW]	Net energy exported [MWh]	Internal consumption [MWh]	Load factor [%]
TH Amatikulu	12	10	43 775	43 775	51
TH Darnall	13	7	27 388	27 388	44.7
TH Felixton	32	22	79 935	79 935	41.5
TH Maidstone*	29	20	79 582	44 917	45.4
Transvaal Suiker**	20	-	-	-	-

* Combined bagasse/coal plant

** Generation license awarded in June 1998. No data is available.

The cogeneration technology currently used is rather old and produces in average 70 kWh per input ton. Conventional steam cycles can produce 120 kWh/ton and combined cycles up to 460 kWh/ton. Upgrading these installations would significantly increase their electricity export potential. This is an opportunity for EU parties to look at more closely, especially when policy measures are put in place to promote renewable energy generation.

Links for collaboration with relevant EU parties may be established through the European Biomass Association (AEBIOM) and the European Association for the Promotion of Cogeneration (COGEN Europe).

3.4.3.4 Wood industry

Most of the production in this industry consists of kiln-dried timber which demands huge amounts of thermal energy. Almost all of the mills burn their wood wastes for steam generation and buy electricity. Only three of them cogenerate heat and power.

The potential to generate electricity in the sawmills is two to three times the internal demand. The owners are well aware of the power exporting potential but have not installed the equipment needed for economic reasons: the current tariffs for feeding the grid do not justify the investment.

This situation may change in the foreseeable future when policy measures are implemented to promote renewable generation. EU parties may get involved in the process of implementing the cogeneration facilities needed to make use of the existing potential. On this respect, an initial contact with the already mentioned AEBIOM and COGEN Europe may be advisable.

3.4.3.5 The pulp and paper industry

There are 13 plants in this sector that process wood for paper production. These plants self generate electricity for critical processes that demand high reliability in the power supply. Waste wood bark, black liquor and sometimes coal is burned for this generation. The rest of the electricity requirement are supplied by the grid. In 1994 for example, self generation was 279 MW, total demand 590MW, and 335MW were purchased from ESKOM.

The current specific electricity self production is only one third of that reported in similar plants in Scandinavia, so there is potential to more than double the internal generation. This would allow the plants to cover their own demand and sell the excess to the grid. The current tariffs for feeding the grid once again do not justify the investment needed to upgrade the cogeneration facilities.

Policy measures to promote renewable generation could reverse the situation. In the years to come there may be opportunities for EU parties to collaborate in fully exploiting the cogeneration potential of this industry. Initial contacts may be established through relevant EU associations (AEBIOM and COGEN Europe).

A recent development shows the way ahead. In December 2000 NER board granted a license to Biomass Energy Ventures to operate a 17,5 MW power station. The developer plans to use waste products from a paper mill of the Mondi group near Durban to fire the station, which will supply about 15% of the mill's electricity requirements.

4. OFF-GRID RENEWABLE ENERGY

Electrification of households is one of the core objectives of the Reconstruction and Development Programme (RDP) adopted by the Government of South Africa in 1994. The RDP set an accelerated electrification programme to provide electricity for an additional 2.5 million households by the year 2000, thereby increasing the electrification level to about 72 per cent of all households (double the number in 1994). Both grid and non-grid power sources were to be employed.

Throughout South Africa, two-thirds of households have been electrified, whilst in rural areas, more than half the population is not electrified (see Section 4.1 for further information on grid connected rural electrification efforts in South Africa). In 1992, ESKOM launched the campaign ‘Electricity for all’ and embarked upon an ambitious programme to electrify South Africa. Despite an impressive record of ESKOM in terms of connecting people, it is estimated that still 3.3 million households are not connected to the grid and that 2.1 million of these will not receive ESKOM electricity in the near future.

For these households, the Department of Minerals and Energy (DME) has developed a mechanism to provide electricity and power to those communities that are not planned to be connected to the electricity grid, the Non-grid Rural Electrification Programme. This Programme is meant to start in 2001 and aims at providing energy services to 300,000 households by means of off-grid renewable energy. This ambitious target makes the Non-Grid Electrification Programme the single best opportunity for promoting the large-scale penetration of renewable energy technologies in South Africa. The Non-Grid Electrification Programme and other off-grid renewable energy initiatives are highlighted in Section 4.2.

Two of the key national priorities in South Africa are job creation and rural development. The issue of improving energy services in rural areas is very much inter-linked with both these priorities. The key policy challenge facing South Africa is to address these three issues in an integrated manner and is discussed in Section 4.3. Section 4.4 identifies opportunities for future actions.

4.1 Grid connected rural electrification

In 1998, the Government released the White Paper on Energy Policy (DME, 1998). The Paper is aimed at clarifying government policy regarding the supply and consumption of energy, but it does not attempt to deal with implementation strategies, as they are part of the core functions of the Department of Minerals and Energy (DME). The White Paper’s objective is to constitute a formal framework for the operation of the energy sector within the broader national economic development strategy.

DME considers electrification as the most important policy objective of the White Paper in the electricity sub-sector. This criterion is consistent with the broader socio-economic targets of the RDP and with the important electrification process led by ESKOM mainly through grid-connections. The White Paper recognises the role of Solar Homes Systems (SHS) and other renewable energy technologies in providing energy services to remote rural communities.

Most of the 43 million South Africans live in urban areas. 80% of the urban households are connected to the grid. In rural areas, more than half the population is not electrified. This high connection rate in urban areas coupled with the high urbanisation rate results in two out of three people in South Africa being connected to the grid.

Table 4.1 *Grid electrification in South Africa*

	Rural	Urban	Total
Population	20,009,245	23,045,062	43,054,307
Houses	3,873,988	5,752,528	9,626,516
Houses electrified	1,793,193	4,585,185	6,378,378
Houses not electrified	2,080,795	1,167,343	3,248,138
% electrified	46.3	79.7	66.3
% not electrified	53.7	20.3	33.7

Source: DME, 2000c (adapted from Thom, 2000)

ESKOM's electrification Programme

Since 1992, ESKOM has launched the campaign 'Electricity for all' and embarked upon an ambitious programme to electrify South Africa. Despite an impressive record in terms of connecting people, it is estimated that by year 2000 3.3 million households were still not connected to the grid and that 2.1 million rural households will not receive ESKOM electricity in the near future.

ESKOM is the main financial contributor to the electrification programme, both through direct investment and grants to municipalities for electrification projects. In 1994 ESKOM committed itself to electrify 1,750,000 houses by year 2000 and exceeded this target in 1999. Recently ESKOM set itself a three-year target of a further 600,000 connections, giving more attention to rural areas.

The upcoming restructuring of the electricity industry and the creation of the National Electrification Fund, will eventually cause ESKOM to withdraw from directly funding and implementing electrification.

However, given ESKOM's central role in meeting electrification targets, it is expected that the utility will continue to pursue electrification during the transition period, financed by subsidies from the electrification fund rather than by internal cross-subsidies.

As electrification in urban areas is reaching saturation, a bigger share of resources will be available for rural electrification.

Table 4.2 *Electrification connections since 1994*

	1994	1995	1996	1997	1998	1999
ESKOM	254,383	313,179	307,047	274,345	280,977	293,006
Local government	164,535	150,454	137,534	213,768	136,074	144,043
Farm workers	16,838	15,134	9,414	11,198	10,375	6,241
Total	435,756	478,767	453,995	499,311	427,426	443,290
RDP targets	350,000	400,000	450,000	450,000	450,000	450,000

* Expected connections in 2000 were 350,000
(Source: Kotzé 2000, as in Thom et al., 2000)

4.2 Current initiatives

4.2.1 Non-Grid Electrification Programme

The South African Department of Minerals and Energy (DME) has developed a mechanism to provide electricity and power to those communities that are not planned to be connected to the electricity grid. In 1999, a process was started in which private companies will be awarded concessions to supply energy services to rural households beyond the reach of the national grid by means of the fee-for-service (FFS) approach.

In the FFS approach, an energy service company provides solar electricity for a monthly fee to rural households such as utilities do for grid-connected electricity. Although the system is based in the house of the customer, the system will be owned and maintained by the energy-service company. The concessionaire will have to invest in setting up a rural infrastructure to implement the activities, but will also have the monopoly right to supply energy services in his area. The concessionaires will be supervised by the NER. International experience with the FFS approach reveals that in almost all of the countries where the FFS approach is applied, the energy-services company will be regulated by government and awarded monopoly status for specific geographic regions (Martinot et al., 2000; Martinot and Reich, 2000).

The objective of the concession pilot programme in South Africa is to electrify 300,000 households in 5 years, divided into 50,000 households per concessionaire. The energy service companies could in principal deploy any technology they think is the most appropriate to deliver the energy services to the end-users. With regard to South Africa, in most cases the concessionaires will use solar PV systems, given the low ability to pay of the end-users, the dispersed nature of the households and the lack of institutional end-users.

In order to create a level playing field for renewable energy technologies, the concessionaires will receive the same subsidy as ESKOM per established connection, which is Rand 3000. Based on a SHS price of about R.3500-4000 this is about 75% subsidy of the initial hardware. As of the end of 2000, there would not be a subsidy on the tariffs of SHS, but DME might consider this once experience shows that the monthly tariffs for year 2000 of around R. 45 were too high.

Important stakeholders

A number of key players are involved in the concession approach. They are:

- DME
- NER
- Concedantes
- The private consortiums forming concessionaires.

Concedantes

ESKOM and the Durban Electricity Authority, being the licensed electricity distributors in the relevant areas, will function as concedantes in this whole process. The role of concedantes is to monitor the implementation of the concessions to ensure that the services are delivered as per the contract. Another role of the concedante is to ensure that the necessary planning takes place that will allow the integration of the grid and off-grid electrification activities (Banks et al., 2000).

National Electricity Regulator

The National Electricity Regulator is the national regulating body of the electricity supply industry. The NER is at present not only responsible for the issuing licenses for electricity distribution, it has also been mandated by the DME to regulate the implementation of the Non-grid Electrification Programme.

The NER as one of its functions in the concession programme, dispenses the subsidy for each system installed to the concessionaire. NER is also responsible for identifying target areas for concessions, granting licenses to concessionaires, controlling prices, setting service standards, settlement of disputes, and monitoring and evaluation of the programme (NER, 2000b). This latter role is overlapping with the role of the concedante to prevent ESKOM getting insight into commercially sensitive information from (potential) competitors (Banks et al., 2000).

Institutional structure of the National Electrification Programme

Figure 3.2 summarises the institutional structure of the rural electrification programme, including both grid and non-grid. The DME is the responsible Government Department, the NER (and the future National Electricity Fund) is responsible for the regulatory framework and the funding of grid electrification through either ESKOM or local utilities (after the electricity restructuring the Regional Electricity Distributors, or non-grid electrification through the concessionaires.

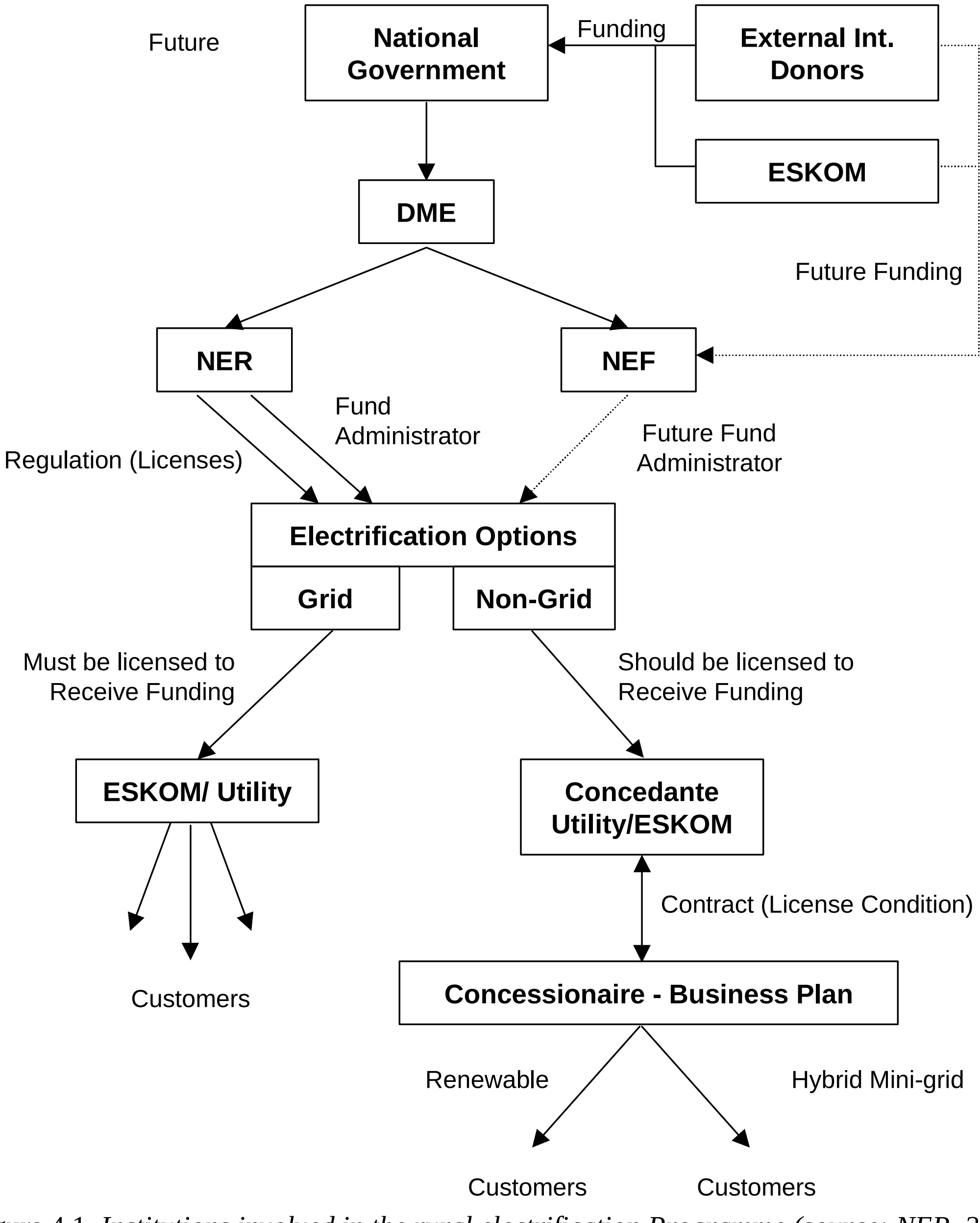

Figure 4.1 *Institutions involved in the rural electrification Programme (source: NER, 2000b)*

4.2.2 The commercial solar market

Banks et al. (2000) estimate that total sales of SHSs in South Africa through the cash market amounts up to 50,000 systems since the start of commercial SHS activities. This amounts to less than 1% of the initially un-electrified community. This seems however a conservative estimate. Stassen and Holm (1996) estimated an installed capacity in 1994 of 40,000 systems. Based on the figures in Stassen and Holm (1996) a yearly production of 12,000 SHS can be estimated, resulting in total installed systems of 70-80,000 in South Africa in 2000. Based on the unverified accounts from our field survey among SHS companies, the yearly sold figures would also mount up to 12,000-15,000 systems a year. This does not look impressive compared to the target group for SHS, it only covers 0.5% (see Stassen and Holm, 1996; Banks et al., 2000). Compared to other SHS markets in the world, however, the figure of 50,000 to 80,000 systems puts South Africa in the top ten of SHS markets in the world (compare with Nieuwenhout et al., 2000, p.16).

Commercial retail channels for cash sales

An interesting finding is that all companies in this category distributed their systems through urban centres, not via rural distribution networks. Arguments mentioned by companies to the reasons for this are:

- Maintaining a rural network for SHS delivery was clearly seen as too expensive for the low margins on PV systems.
- SHS belongs to a category of products, durable consumer products, for which customers spend a lot of money and for which they are willing to travel as opposed to convenience goods. Customers also purchase their television, radio and other electrical appliances in urban centres, so why not SHSs?
- SHS are often donated to rural end-users by urban relatives, who earn a higher income than their rural family. There exists thus an urban client base for SHS even though they are not the end-users.

The commercial retail channels for cash sales can be subdivided in:

- Sales from own workshop
- Integrated retail channel
- Independent retail channels.

Sales from own workshop:

This is a limited strategy: low costs low results. It is mostly applied by PV companies for whom the SHS market is not their core market. Thus they will serve the upmarket SHS clients with specific design requirements.

Integrated retail channels

PV companies who have their own existing retail channels can use them for SHS as well. In South Africa, this was found for the battery producers.

Independent distribution channels:

This is a retail channel in which no contractual relation exists between retailer and wholesaler and where the retailer supplies different types of SHS on a more or less regular basis. The scope of this research was too limited to do an extensive research to existing retail channels in South Africa, but they include:

- Major chain groups: Makro, Dion, Games, etc
- Supermarkets – Supermarkets may see certain advantages in dumping cheap PV panels but will have little opportunity to provide back-up services.
- Mine worker concession stores - A concession store is a store at a mineworkers compound who hold the monopoly right to sell to the mineworkers. These stores also sell PV panels which mine-workers will buy for their families in rural areas. This channel was brought up as an example of how PV has got a bad name in South Africa. Since the concession stores have monopoly right to sell to the mineworkers and the buyers are not the ultimate end-users, they have an incentive to sell low quality products.

Credit

South Africa has relatively little experience in applying micro-credit for SHSs. Credit is used to purchase furniture and fridges. As one of the respondents noted, unlike SHSs, these products have high margins for the retailers, which limits the relevance of their credit mechanisms for SHSs. Their higher margins can facilitate the credit provision. Also, existing financial retail channels are not geared towards facilitating loans for PV given their high interest rates and short repayment periods.

The general view of interviewed companies is that credit would help the market, but is very difficult to organise. It will only work if it is organised on a commercial basis, but there is not much experience so far. Two of the interviewed companies mentioned experience with credit. The first mentioned of an experience with a pilot project, which failed. The second company was more successful and has been using credit for a long time and experienced little problems. The company installs the system (to know the location of the customer), and the consumer has to pay 50% deposit, and the remaining amount in a 12 months period with a commercial interest rate of 26%. If the customer does not meet its commitment, than the company will take away the panel (about 50% of the cost). This results in people starting to pay again. The lower income customers are typically the market sector that ask for credit.

4.2.3 Solar demonstration projects

Apart from commercial channels or the Non-Grid Electrification Programme, also other sources provide funding for SHSs, such as local government bodies, donors or NGOs. These are typically one-of-a-kind projects and as such they can hardly be qualified as a retail strategy for SHS as the driving actor is not the company but the donor. A number of non-grid electrification pilot projects have been implemented in South Africa (see Table 3.11).

Table 4.3 *Demonstration SHS projects in South Africa (Source: Thom et. al., 2000)*

Project area	Description	SHS installed	Support	System size
KwaBhaza	the provision of an integrated energy package at KwaBhaza by ESKOM and Total.	140	R1500/SHS Finance	49 Wp
Maphephethe	A private commercial non-subsidised SHS dissemination pilot at Maphephethe.	60	Project development Loan	55 Wp
Folovhodwe	A joint project between the Bavarian government and the DME at Folovhodwe in the Northern Province.			
Free State farm workers programme	A District Council initiative to supply farm workers with SHS in the Free State Province.	1800	R2000-2500/SHS	50 Wp (estimate)

4.2.4 CSIR Lubisi project

The Lubisi Dam project started in 1994 as a project to demonstrate the use of renewable (hydro, wind, solar and biomass) energy to accelerate development in a rural area. Since then the project has become an integrated and integrative project to demonstrate a wide range of suitable technologies in the creation of jobs. The project has been assisted by CSIR Corporate Investment Thrust status since late 1996.

During the first 18 months of the project, no technology flow occurred at all, as the time was spend on the sociological aspects of encouraging the local people to form a representative structure. This structure could strategically plan for development in the area in the knowledge that all elements of the local society, including women, traditional leaders, youth, churches, political parties and others would be included in the decision making processes. The resultant structure consists of the Conference (6 members from each of the 23 participating villages), who elect a 23 member Forum, and finally the 6 member Executive, with a total of about 80 000 people now being able to participate and make decisions about the overall development of their area.

The Forum was then led through and participated in a SWOT[4] analysis and a survey to determine local resources and needs. Out of this process emerged the five top priorities, with overwhelming consensus, for the community as a whole:
1. Water supply
2. Agriculture
3. Job creation through Small and Medium Enterprises
4. Transport and transport infrastructure
5. Energy and electricity.

Energy was seen to be key to any future development. The region is currently off-grid.

The CSIR subsequently embarked on a series of feasibility studies to determine, from the local resource base and its own knowledge, the range of technologies that could be applied and the extent of sustainable job creation. A number of reports now exist in this regard and a number of potential projects have been identified. These include:

a) Water supply projects totalling R 25 million now submitted to The Department of Water Affairs and Forestry (DWAF) for approval.
b) Fish farming, resulting in the creation of a least 6 small subsistence fishing enterprises, with a potential annual income of around R 200 000.
c) Road upgrading training, to enable the local people to crush their own stone and upgrade local roads by themselves
d) Cotton farming under irrigation, in conjunction with a local Cotton company
e) Fence making in conjunction with better stock management training, to enable the creation of permanent pasture for sheep and goats
f) Boat building, an SME to complement the fish farming
g) Fish hatchery and breeding (trout)
h) Micro-hydro electric plant driven by a local spring to supply power to the fish hatchery
i) Six small wind turbines from Scotland, funded 50% by Scottish Enterprises and 50% by CSIR, to power woodworking and other job creation projects
j) Manufacture of wooden toys and ornaments for export
k) A sewing group involving up to 180 women to produce ethnic garments for export
l) A nursery project to cultivate drought resistant fodder
m) A home garden project to enhance the home cultivation of vegetables
n) A school leaver's training pilot to learn employment skills in conjunction with the SLOT organisation
o) A waste recovery and water utilisation project to generate fertiliser, bio-gas and compost in a pilot project towards the creation of sustainable villages where water supply is coupled with job creation, energy needs and food production
p) An overall feasibility project to determine the uses to which a large-scale hydro-electric plant installed on the dam itself could be put to attain the overall transformation of the area.
q) A feasibility study with possible Finnish government funding to investigate the sustainable utilisation of existing plantation and natural forest resources in the area for energy and industrial use.

4.2.5 Remote area power supply programme - IDT[5]

Gwagwa (2000) mentions of the plans for a remote area power supply programme, which will provide an opportunity for partnerships to bring the greatest impact in rural economic development through energisation. It is envisaged that the programme will be launched through the initiation of 50 pilot projects sites across the country.

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4 An analysis focusing on Strengths-Weaknesses-Opportunities-Threats of the subject.
5 Entire section based on Gwagwa (2000).

Three ingredients are needed to pilot such projects successfully:
- technology,
- financing, and
- institutional capacity.

The technology for viable off-grid electrification of communities (rather than households) based on renewables is available, proven and reliable. Financing for piloting off-grid projects to accelerate the pace of rural electrification is available from a variety of concessional sources.

In addition, by bringing in private and NGO partners in the delivery of public policy, Independent Development Trust (IDT) is also enhancing the capacity of Government in implementing its policies, and:
- Crystallising the integrative potential of energisation.
- Being an integrative facilitator in the process of rural development by bringing together various role players who could add value to the process.
- Working with experts in the energy field to find practical energy solutions to local economic needs.
- Alternative forms of energisation that are inherently short term with a view to crystallise local communities into economic activities that eventually lead to integration with the main grid.
- Make communities understand the importance of energy as a key to enhancing their own aspirations for development.
- Instil within technical experts an understanding of the needs of the people and the cultural and social frameworks within which energisation will be determined and applied.
- Ensuring that the focus of interventions should be to make traditional ways of rural communities more efficient.
- IDT drawing on its comparative advantage in terms of mobilising community groups in the delivery of services and acting as a bridge between the public and private sector, the NGOs and communities.

The 'gap' in making progress with off-grid rural electrification lies in the institutional capability needed to undertake and implement such pilot projects successfully. Unlike many other countries, South Africa does not have a rural electrification administration or a network of rural electricity co-operatives. But it has a rich endowment of NGOs which have successfully implemented infrastructure projects at village and community levels. Therefore, although it is not clear immediately which institutions should be the implementing agencies for such an initiative in South Africa, three clear possibilities exist:

a. A large NGO which has proven experience and the internal staff capability to undertake rural infrastructure provision and work effectively at the community level;
b. ESKOM itself, which has the monopoly and mandate to universalise electricity provision but which is constrained by the other urgent demands being made upon its resources and by considerations involving its own evolution and transformation and
c. Sub-national governments, such as the Provinces, local governments or rural districts.

The IDT understands that the technical aspects of energy are quite specialised and it would make no claims to be experts in this regard. Which is why the building of partnerships brings to the scene the required and relevant expertise for an integrated approach to rural development especially as it relates to growing and developing these local economies and the potential that resides within them.

4.2.6 Hluleka Nature Reserve: Mini-Grid

The potential for eco-tourism at the Hluleka Nature Reserve provides an anchor for new economic activities that could benefit the nature reserve as well as create new jobs for the adjacent community. Discussions with ESKOM have revealed that it is unlikely that the electricity grid will be extended to the Hluleka Nature Reserve area. Consequently, if the potential demand for electricity and power is not stimulated through the establishment and stimulation of new economic activities then it is unlikely that sustainable socio-economic upliftment of the area will occur.

The Mini-Grid Concept

As it is unlikely that the grid will be extended to the Hluleka Nature Reserve area alternative options need to be implemented to provide adequate electricity and power. An option that should be considered is the mini-grid concept. Essentially a mini-grid concept consists of a small power station that provides electricity and power distributed to economic activities and houses in relative close proximity. The power station and distribution network are initially not connected to the main grid.

The small power station could utilise the natural resources in the area such as renewable energy, i.e. wind, biomass, solar, mini-hydro etc. The mini-grid could be complimented by Solar Home Systems.

Potential Benefits of Mini-Grid Concept

- Stimulation of new economic activities
- If at some stage the mini-grid is connected to the main grid, it will boost and stabilise the main grid that is likely to have been weakened by the Electrification Programme.
- Since the mini-grid concept has hardly been applied in South Africa, its implementation in the Hluleka area will also provide the additional benefit of providing inputs into the Integrated Energy Planning process. This will facilitate the replication of the mini-grid concept into much of the non-grid areas of Southern Africa.

4.3 Barriers and key issues in off-grid renewable energy

The issue of improving energy services in rural areas is very much inter-linked with job creation as well as within the broader concept of rural development, one of the national priorities in South Africa. The dilemma is: people will not be able to pay for improved energy services because they earn too little income; and people earn little income because they lack an appropriate infrastructure for income generation. This latter is basically confined to energy, telecommunications, roads and to a lesser extent on water supply. Also with regard to broader rural development, energy can play a key role in enabling other social services, such as health and education. The key challenge for rural energy in South Africa is therefore to promote simultaneously income generation activities and rural energy provision.

In this section, the purpose is to analyse how renewable energy can contribute into the broader framework of rural development, but first the key issues facing the Non-Grid Electrification Programme, as one of the key facilitators of rural energy services, are discussed.

4.3.1 Implementation of the Non-grid Electrification Programme

In terms of its size, structure and challenges, the concession programme is a unique project embarked upon by the Government of South Africa, and belongs among the cutting edge policy approaches of off-grid rural electrification in the world. If it is to be successful, it will have provided 300,000 households with off-grid renewable energy (mostly Solar Home Systems) and will have set the stage for further large-scale deployment of renewables to rural communities in South Africa. Given its innovative nature and its size there is likely to be a lot of policy challenges for DME during the implementation phase of this programme. In anticipation of the implementation, the following hurdles may be expected.

ESKOM-concessionaires relations
ESKOM has yet to reveal what their grid extension programmes are in the assigned concession areas. The negotiations between DME and ESKOM on this subject are still going on. Below this issue is a more substantiated point that the South African case is quite particular due to the presence of ESKOM. In the current situation, two companies have the monopoly right to provide energy services to rural households. ESKOM for grid connected, and the concessionaire for the remaining technologies. Since grid-extension is the most favoured technology if it is viable, the concessionaire will have to wait with the plans of ESKOM. Potential problems:

- There may be technological shade areas, where it is not clear who is responsible
- Risk exposure versus rewards. Experience from other countries (Chile) reveals that businesses do not merit rural electrification on the current cash flows, but also on expected future cash flows. These are likely to increase over time due to development of rural areas and corresponding increased energy demand. In the case of the concessionaires, a situation may develop where they take all the risk in putting up local infrastructure, promoting development and increasing energy demand, and once a profitable sustainable market has arisen, ESKOM may come in with grid extension and take over the customers from the concessionaires. This risk in itself may provide a disincentive to the concessionaires to invest in larger systems, such as mini-grids, which may have more potential in the long run or promote income generation activities and other development benefits.
- ESKOM may not be able/willing to provide detailed cases of its grid extension programmes. For instance, villagers in Maphephethe, where a solar pilot project took place, where greatly annoyed to find out that grid was extended to neighbouring villages three years after the start of the project, while at the beginning of the solar project ESKOM declared that the area would not be electrified for at least five years (Annecke, 1999).
- The Electricity Sector Industry is undergoing a restructuring process (see elsewhere in this study). It is highly likely that competition will be introduced. ESKOM may not be very much willing to co-operate with each of the concessionaires, who may turn out to be their direct competitor within a few years.

Fee-for-service concept
The fee-for-service concept applied in the concession systems is an innovative approach to disseminate PV systems to rural household. However, there are few proven examples of the concept so far.

- The payment discipline required under the programme may be too strict for rural households. Experience in Uganda reveals that keeping up payment discipline among end-users is hard when it's getting over a year time;
- Another issue is ownership. Interviews held among local PV dealers saw as the biggest disadvantage of the fee-for-service concept the lack of ownership of households. There are two reasons behind ownership: 1) households prefer to own the system, and 2) ownership is clearer incentive for the household to learn about operation and maintenance.
- Social impact - Thom et al. (2000) argue that the monthly fee of R. 50 will not be affordable to a large percentage of rural households and that a large-scale subsidised programme like the Non-Grid Electrification Programme will only benefit the more affluent households in rural areas.

The bad image of PV

- Desirability of PV - PV is not always the most preferred technology in rural areas. This is partly due to the 'Electricity for all' promise of ESKOM in the early nineties, which made people wanting to wait for grid-connection, because of inferior PV products sold in the past by commercial 'fly-by-night' operators, and because PV is seen as a second class supply since it has low capacity (e.g. not possible to cook or heat water) but a much higher kWh cost that grid supply.

4.3.2 Renewable energy and income generation

In a global evaluation study of the socio-economic impacts of renewable energies Aguado-Monsonet (1998) noted the significant impact renewable electricity projects had on stimulating local productive activities. It was concluded that productive activities were stimulated in 65% of the wind projects, 50% of the biomass projects and in 40% of the PV projects. Another conclusion which became clear from these results is that larger systems have a higher impact than smaller systems. The global survey also indicated that the rural electrification had a positive impact on social projects and played a role in preventing migration to the urban areas.

What type of income generating activities could be generated with renewable energy? The promotion of renewable applications in rural areas can have positive impact on job creation in South Africa in the following three areas:

1. Manufacturing
    - Manufacturing of renewable energy systems, once they are locally produced
    - Manufacturing of electrical appliances, especially DC appliances. During the People's Power workshop it was noted that there is hardly any manufacturing of DC appliances currently being done in South Africa, while there will be increasing demand, once the concession programme becomes operational.
2. Implementation (Concessionaires)
    - Installation of renewable energy systems.
    - Maintenance of PV systems. Rule of thumb appears to be around 1 person for every 100 PV systems installed (for the 300,000 PV systems under the concession programme that means 3,000 people being employed)
3. Indirect: energy provision for income generation activities

The first category is unlikely to promote rural job creation, since manufacturing is typically done in urban areas. Activity number 2 and 3 however, will lead to job creation in rural areas. Since category 2 is already covered under the concession approach the main challenge with regard to job creation relates to category 3.

Potential income generation activities related to rural electrification can be subdivided into a number of categories:

Household income generation activities

The mere introduction of lighting has enabled people embarking upon new income generation activities. The introduction of solar PV has enabled the following examples:

- sewing machines running directly on solar PV during the day,
- poultry farming by lighting henhouses during the evening,
- video. People running a video and colour TV with their SHS were found organising video evenings for the village and making a profit (Uganda),
- cottage industry.

Small-scale rural enterprises

- hotel, restaurant, bar by having light and PV fridges,
- fishing with solar light. This is obviously confined to areas bordering the sea or great lakes,
- eco-tourism.

Small-scale farming

In the 'Implementation Strategy for Renewable Energy for South Africa' renewable energy for small scale farming was promoted.

> 'Re-introduction and revitalisation of small-scale farming is projected to be backbone of economic stabilisation and growth in many of the economically depressed remote areas. Locally available renewable energy resources could be employed cost-effectively in support of such ventures.' (DME, 2000d, p.33)

Small-scale rural industry
- sawmills
- workshops
- food processing industry (grain milling, coffee factories)

4.3.3 Renewable energy and economic development in the Eastern Cape

CSIR, ECN and Garrad Hassan and Partners Limited undertook a project under the THERMIE programme to investigate 'Renewable energy sources for rural electrification in South Africa' (CSIR, et al., 2000). CSIR was the catalyst for the original proposal and the aim of the project was to identify commercially viable opportunities for rural electrification in the Eastern Cape Province of South Africa using wind, hydro and biomass powered Remote Areas Power Supply systems. The Eastern Cape Province was chosen for the study in view of its low rural electrification rate and relatively good renewable energy resources. The study was premised on the assumptions that:
- the potential for any type of renewable energy system to meet only domestic electricity needs is minimal because consumers could not afford to pay for it,
- the potential for new, electricity dependent economic activities exploiting local natural resources is stifled at present by the lack of access to basic infrastructure, including cost-effective electricity supply,
- cost is the determining factor in limiting further extensions to the grid in the foreseeable future.

It was intended to determine the potential net financial return per unit throughput for a number of selected economic activities. However, the scarcity of information on economic activities in the Eastern Cape Province that became apparent in the course of the study had a major influence on how renewable energy should be used in the rural areas, namely to provide electricity and power to new and productive economic activities.

Within the Eastern Cape Province , due to the likely scenario that grid electricity will not reach much of the area, it was decided to focus effort on the Transkei region. Potential electricity demand forecasts for the magisterial districts that make up the Transkei were developed to the year 2020 in 5 year intervals. These forecasts were done for each of the domestic, agricultural, manufacturing and commercial sectors. Population growth, grid electrification rates and household consumption coefficients were used to derive projections for the domestic sector. Projections for the three non-domestic sectors were derived from sector-specific Gross Geographical Products (GGP's) and electricity consumption coefficients. Because they are indexed to GGP (future trends which are extrapolated from historical trends) the demand forecasts for the agricultural, manufacturing and commercial sectors represent estimates of economic activities which might be expected to occur if historical trends continue.

As an example of a forecast, the aggregated energy demand from each magisterial district of the Transkei for 2010 was determined to be:
domestic - 95% of total
agriculture - 2% of total
manufacturing - <3% of total
commercial - <<1% of total.

Hence, assuming no intervention measures only 5% of demand for electricity in the Transkei in 2010 will be for productive economic activities.

Similar forecasts can be done for the rest of SA and it is highly likely that the demand for electricity in the rural areas for productive economic activities will be a low percentage of total rural electricity demand.

This does not bode well for job creation in the rural areas, particularly since this is a national priority of South Africa.

Hence it is obvious of the significant impact that renewable energy can have on the economic development in the rural areas of South Africa, particularly if such energy is linked to new and productive economic activities.

For the rural areas of the Eastern Cape Province, at least, three economic sectors seem to have good potential for further development in terms of available resources, namely:
- agriculture
- forestry and
- eco-tourism

4.3.4 Co-ordinate electrification with other development programmes

It is important to recognise that the relation of rural electrification to economic development is not straightforward. Apart from the provision of electricity, there are a number of other conditions which have to be met in order for rural electrification to result in net economic benefits for rural areas (these conditions were identified by the World Bank already in 1975; Annecke, 1998). Electrification may contribute to economic development provided that:
- The quality of infrastructure, particularly of road is reasonably good;
- There is evidence of growth of output from agriculture;
- There is evidence of a growing number of productive uses in farms and agro-industries;
- There are a large number of villages, not too widely scattered;
- Income and living standards are improving;
- There are plans for developing the area.

Apart from these, also the provision of a basic telecommunications network is often considered as an important element in order to provide telecommunication and basic multi-media services. Besides the focus on economic development, also the contribution of electrification towards social development will require additional support.

This has been reflected in the new integrated approach of the National Electrification Strategy, in which the 'promotion of socio-economic development of previously disadvantaged communities' through institutional electrification and 'integration of electricity with other infrastructure creation initiatives and other social and economic development programmes' are recognised (Thom et al., 2000)

This approach links closely to, what in development circles has been called, the sustainable livelihood approach. In this approach it 'is not sufficient to simply provide a service to the community, but rather to support that community in generating the demand for the given service'(Gwagwa, 2000, p.6). Creating income generating activities is a very real challenge in South Africa's rural areas where high unemployment results in considerable poverty (see Table 4.4).

Table 4.4 *Stratification of rural population, Source: Gwagwa (2000)*

Stratification	[%] in each class
Very poor (< R600 per person per month)	25
Poor (< R1000 p.p.p.m.)	38
Remaining	37
Total	100

In order to improve the impact of energy services on development, an integrated approach in which the provision of improved energy services is co-ordinated with other development approaches is required. The actors for off-grid renewables will be the concessionaires, ESKOM and future REDs.

Thom et al. (2000) list a number of recommendations regarding the co-ordination of the rural energy programme with other development programmes, including:

- Domestic water supply projects - Department of Water Affairs and Forestry (DWAF)
- Irrigation projects as part of small-scale agricultural schemes involving collectives of small growers
- Clinic electrification programme - Department of Health
- School electrification programme - Department of Education
- Institutions responsible for Small and Medium Scale Enterprise development (for example Ntsika Enterprise Promotion Agency

Other areas for collaboration are:

- The business development programmes for which the Department of Trade and Industry is responsible.
- Department for Provincial and Local Government to co-ordinate development efforts and to strengthen local development initiatives.

4.4 Opportunities for further action

4.4.1 Non-grid Electrification Programme

PV is one of the most proven renewable energy technologies in developing countries because of its cost effectiveness in one niche-market: the niche-market of stand-alone systems for small electricity loads. It is also an interesting technology for the purpose of this research, because on one hand, there are ambitious programmes for the application of PV in rural households in South Africa which will result in a increased demand for PV. On the other hand, PV technology automatically includes international technology transfer, because solar PV cells, the nucleus of the technology, are only produced in industrialised countries, including in quite a number of EU member states.

In South Africa there is already a rather developed market for PV-systems providing electricity to rural households. Several projects have been realised and there exists a cash market to households. A new, promising development is the non-grid rural electrification programme in which the Ministry for Minerals and Energy is granting concessions to private companies in order to provide rural households with energy services by means of the fee-for-service approach. Apart from these initiatives, there exists a well-developed PV market in South Africa including the electrification of schools and clinics, Telecom applications and water pumping. In the report an analysis of the opportunities and barriers of the different markets has been made, providing input for the following recommendations, in which also the EU and its member states could offer major contributions:

1. Technical assistance to DME

In terms of its size, structure and challenges, the concession programme is a unique project embarked upon by the Government of South Africa, and belongs among the cutting edge policy approaches of off-grid rural electrification in the world. Especially given its size and the fact that it is not sponsored by the GEF (compare with other initiatives in Martinot et al. (2000). If it is to be successful, it will have implemented 300,000 SHSs and will have set the stage for further large-scale deployment of renewables to provide electricity to rural communities in South Africa.

Given this unique character of the programme, it may be good to provide long term technical assistance to DME during the implementation of the programme, which DME can deploy whenever there are new issues on the horizon. This technical assistance could focus on strengthening the monitoring and evaluation capacity at DME and assist in finding creative solutions for the problems and draw lessons from international experience. Apart from improving the performance of the South African programme, the improved monitoring and evaluation of the programme will make it more easy for other countries to draw valuable lessons learned from this programme.

2. Flexibility to address implementation issues

This programme is at the moment the largest opportunity for promoting the large-scale penetration of renewable energy technologies in South Africa. Given its experimental nature, there is likely be a lot of policy challenges for DME during the implementation phase of this programme. Policy flexibility on the side of DME is therefore an important component to meet its ambitious targets. without jeopardising the needs of the end-users and the financial operations of the private companies.

4.4.2 Commercial market

1. Launch integrated PV follow up programme

Apart from addressing PV SHSs for rural households, DME may also wish to consider developing PV policy targeted at commercially sold PV SHSs and other PV systems. Such policies could target improvement of operation and maintenance of installed PV systems and thereby improving the public image and acceptance of PV systems. Key components of such programmes are training of solar technicians, and creating awareness amongst end-users to enable them to make informed choices.

Although part of such components can be found in individual programmes, it is crucial for the image of PV that such issues are addressed during in integrated programme. Morris (2000) launched the idea to set up a big maintenance campaign to provide after-sales services to all the pilot projects, which overlooked that, as well as the clinics and schools programmes. The idea was that before starting new pilot project, first clean up the mess of the old ones.

Such a programme can at the same time be combined with training local technicians, and raising awareness on the potential of PV among end-users, and train end-users on how to properly use and maintain PV systems. A potential way to implement such a programme would be under the sector specific education support programme. It could also be linked to the PV infrastructure which will be put up by the concessionaires. Stakeholders to be involved in this programme are the concessionaires, PV suppliers, ESKOM, DTI, DME, DoH.

2. Create a sustainable business environment for PV

The SHS market for rural households is highly integrated with other PV markets. There are few suppliers, international and local, who concentrate solely on the households markets. Government agencies and para-statals together are responsible for a large demand for PV panels. They could use this market power to co-ordinate and distribute their demand more evenly over time. This will allow the South African market for PV better anticipate demand and hence provide their customers with better services and lower prices.

4.4.3 Integrate renewable energy policy into Integrated Development Planning

The major challenge when trying to integrate energy into other development activities is the level where the integration will take place. In the past many national and provincial government programmes have failed at the point of delivery due to lack of capacity or involvement of local governments. As a reaction, The Department of Provincial and Local Government has introduced the Integrated Development Planning (IDP) tool. IDP is the tool for reorganising local government and setting strategic frameworks for project delivery. In the week of 18 September, legislation was passed that every district will have to submit IDPs. The objectives of this is that it will become a means of mediating between national, provincial objectives and local priorities (Patel, 2000). The level where electrification plans can be integrated with other development initiatives has to match with the existing institutional structure the SA government to promote rural development, which is the IDP process.

Box 1 Major implication of new municipal boundaries (Patel, 2000)

The re-demarcation of municipal boundaries has major implications for rural development in South Africa:

1. For the first time many rural areas will fall under the jurisdiction of a municipality
2. Most rural areas will be amalgamated with urban centres or peri-urban nodes to form single municipalities
3. This has implications for institutional and administrative arrangements but more importantly the question of rural and urban migration has a better chance of being addressed;
4. Rural areas will have the opportunity of accessing the revenue bases of urban centres
5. Capacity problems in rural areas can partly be solved by amalgamation
6. Rural development strategies and programmes will be incorporated in a much more focused way in municipal plans (that is IDPs)

Current capacity at the local level is limited, but initiatives are underway (for instance through the Independent Development Trust) to develop local capacity (Patel, 2000):

- Municipalities will require technical assistance to identify and elaborate appropriate energy programmes
- The Department of Provincial and Local Government is in the process of establishing PIMS-Centres (Planing and Implementation Management Support Centres) at each new District Municipality to bolster local government planning and delivery capacity.
- The Integrated Sustainable Rural Development Strategy (ISDR strategy) suggest a tool for data and information collection and analysis to support local planning processes.

Energisation plans

Considering that energy issues and income generations are high on the priority list of rural communities, developing energy planning tools at district to assist energy planning and decision-making is very relevant. It will enable local communities to make informed choices of what is feasible and will help them expressing their needs towards ESKOM or concessionaire in that area. Such tool could be made available through the PIMS-Centre or other relevant local body.

A parallel can be found with the experience in Namibia. The long-term energy planning process enabled local communities to assess the future of their energy situation, and enabled them to respond to it and get into active negotiations with policy makers (Morris, 2000).

4.4.4 Strengthening implementation capacity at the local level

By setting up the concession system, there is now an implementation capacity in place to deliver energy services in rural areas. The concessionaires will in the first instance be very much focused on delivering energy services to rural households, i.e. for consumptive applications. At the same time, there is a need for establishing energy services for rural industries as well. This raises the interesting question how the concession could exploit that market as well.

Linking municipalities with the concessionaires and relevant ESKOM departments
The concessionaires are established at the national level by DME, while the development planning through the IDP will take place at the district level. It seems therefore a priority to link the planners at the municipal level with the concessionaires. The concessionaire and the municipality could engage in the energy planning for each area and identify potential energy activities. Through such a process, concessionaires can be linked to income generation activities and assist in providing energy solutions to those initiatives.

4.4.5 Support mechanisms to stimulate the implementation of hybrid mini-grid systems

The government should try to put in place separate measures to facilitate the investments in renewable energy projects to economic activities in rural areas, likewise they had done it for households. During the concluding workshop of this study, a number of barriers were identified hindering the deployment of renewable energy for economic activities:

- lack of training & awareness,
- lack of funding,
- Sectoral instead of holistic approach blocking development initiatives,
- High-risk,
- No IPP-framework,
- Confusion on ESKOM task division.

Of the main barriers to economic activities is the lack of rural economic activities. This could be advantaged by integrating energy into the IDP process (see point above) with a special emphasis on involving local communities.

It was concluded that the concessionaires should be the main responsible for providing energy services to economic activities in rural areas (see also previous point). They would have access to finance to develop decentralised energy projects and could in turn sell the power to the project developer under a power purchase agreement. However, concessionaires would only get engaged if such ventures are commercially viable for them. Energy projects for economic activities require higher investments than household and hence are surrounded with more risk. They involve small-scale activities from companies which often have no financial track record and which face uncertain market prospects. Special support measures, similar to the ones provided to rural households, are therefore also required for off-grid renewable energy projects for economic activities. Such measures could include:

- subsidy on capital expenditures (similar to the one provided for households) to create a level playing field with grid extension,
- guarantee fund to provide guarantees for the power purchase agreement,
- assistance to project developers: economic, financial, legal skills to set up commercial projects,
- integrate this into the IDP process (see point above),
- make concessionaires responsible for such activities (see point above).

Section II

European experiences and potential contributions

5. RENEWABLE ENERGY TECHNOLOGIES IN THE EUROPEAN UNION

The following is a review of the present state-of-the-art renewable energy technologies available in the European Union(EU)[6]. An overview is given of the different technologies available; after that, the current market position of the specific technology is described, followed by the main market barriers and opportunities. Lastly, the relative competitiveness of the technology is outlined and the relevance for South Africa is discussed.

5.1 Wave Energy

Waves, particularly those of large amplitude, contain large amounts of energy. Wave energy is in effect a stored and concentrated form of solar energy, since the winds that produce waves are caused by pressure differences in the atmosphere arising from solar heating. The strong winds blowing across the Atlantic Ocean create large waves, making the west coast of Europe ideally suited to wave energy schemes.

5.1.1 The Technology

Wave energy is a relatively new technology. Research was most intense during the 1970s and '80s under various government and industry sponsored programmes. Wave energy research is still carried on and has benefited from funding provided by the European Commission (EC). As a result, a wide variety of wave energy devices have been proposed over the last three decades. These comprise many different shapes, sizes and energy extraction methods. Although most of them never passed beyond the outline design stage, some have been the object of intensive research and development work and a number have been deployed in the sea as prototypes or demonstration schemes.

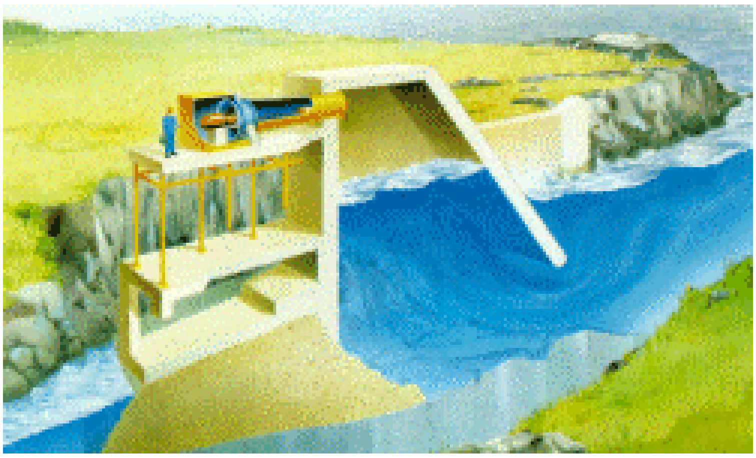

Figure 5.1 *Sidecut view of Scottisch Wavepower technology (source: http://www.europa.eu.int/)*

The main EU countries involved with the development of wave power have been Denmark, Ireland, Portugal, UK. These projects have been developed independently and so a wide variety of possible technologies have been developed. Most of these remain in the research stage but a small number have been deployed in the sea as demonstration schemes.

6 Source: http://www.europa.eu.int/en/comm/dg17/atlas/

Several ways of classifying wave energy devices have been proposed, based on the energy extraction method, the size of the device, etc. The method adopted here uses the location of the device with respect to the shoreline, i.e. shoreline devices, near-shore devices and off-shore devices. Only devices at or near the demonstration stage or which at least have been object of substantial research and development (R & D) effort will be considered here.

The wave energy potential in the EU has been estimated conservatively as 120-190 TWh/year (offshore) and 34-46 TWh / year (near-shore). The global wave power resource is in excess of 2 TW, with potential for generation of more than 2000 TWh annually.

5.1.2 The market

Wave energy technology has developed to the stage where the first demonstration schemes are being built, so there is only a small market at present. Wave energy (like many other renewables) is unlikely to be economically competitive with conventional generation capacity in the immediate future, except for isolated communities that are not connected to the grid. This situation could change in the medium-term future:

- technology developments have already reduced the predicted costs of wave energy ten times over the past two decades.
- wave energy could supply coastal communities in those countries without a national electricity grid, thereby avoiding transmission line costs;
- wave energy could supply arid coastal communities with potable water.

A conservative estimate indicates a future global wave energy market (in 2010) of approximately 5.5 TWh per year. The overall future market for wave energy is in excess of 2000 TWh.

5.1.3 European competitiveness

Europe still remains the world leader in wave energy technology. With some European countries investing in R&D or demonstration projects, the EU should be well placed to compete when a commercial market for the technology evolves. Several commercial devices are currently under construction and planned for export. However, there are significant advances being made in non-European countries (e.g. India, Japan and USA).

Figure 5.2 *Landward view of 500 kW Scottish wave power technology at Limpet, Islay (source: Wavegen , 1999)*

5.1.4 Market Barriers

There are a number of non- technical barriers to the successful development of wave energy. These include long development times and high development costs as well as perceived risk and high historical costs. It is essential that the current demonstration schemes are successful in order to overcome these barriers.

5.1.5 Relevance for South Africa

Wave power is in its infancy. Commercial units are only now being developed and generating costs are therefore higher than they will be in a few years time. It is expected that wave power development will be similar to wind power where it took a number of years for it to become competitive. There are extensive stretches of the South African coastline where wave power could be expected to be commercially viable at some point in the future.

5.2 Wind energy

Wind energy is one of the most promising renewable energy technologies. Modern wind turbines for power generation became popular in the early 1980s. Development was initially focused in the USA but, since 1988, Europe has been the fastest growing market.

5.2.1 The Technology

Wind turbines extract energy from the wind by transferring the momentum of passing air to the rotor blades. Energy is thus concentrated into a single rotating shaft. The power in the shaft can be used in many ways; modern turbines convert it into electricity. Rotors can be set on either a horizontal or a vertical shaft. However, horizontal axis turbines have proved the more cost-effective option and dominate the world market. Vertical axis machines have made no significant contribution in Europe.

Figure 5.3 *Wind farm in Greece (Source: http://www.europa.eu.int/)*

Wind energy costs have fallen dramatically in recent years: costs in the Netherlands fell by a factor of three between 1985 and 1995 and in Germany by a third between 1991 and 1994. Wind farms due to be developed within the next five years in the UK should generate electricity at costs as low as € 0.03/kWh. Wind energy technology is highly reliable and routinely achieves an availability of 98% and over, but operating experience, particularly with the larger (600kW-plus) machines, is limited to a few years. There is no experience of machines of this size over the projected life spans of 20 years or more.

5.2.2 The Market

Europe's wind energy generating capacity currently totals 3500MW, with world capacity standing at some 6000MW. New capacity continues to be added to the European market at a rate of around 1000MW/year. The trend is towards an increasingly global demand with the 400MW/year of capacity currently being installed outside Europe expected to rise rapidly. It is difficult to make long-term predictions for future installed capacity for wind power due to the complexity and dynamics of world markets. A simplistic estimation from current indicators suggests installed capacities of 17,500MW in Europe and 37,700 world-wide by 2010.

5.2.3 European Competitiveness

European manufacturers have dominated the world market for wind turbines for some years, e.g. about half of all plant installed in 1995 were from Danish manufacturers, nearly a quarter from Germany and much of the remainder from European/Indian joint venture companies.

The European wind industry manufactures machines with a total capacity of 1000MW/year and development of the largest, 1MW-plus, turbines has taken place exclusively in Europe. The other major manufacturing country is the USA, but activity there has reduced considerably in recent years. Japanese manufacturers are also present in the market. All the early wind turbine manufacturers in Europe started as SMEs. This and the inconsistency of local markets for wind have led to many companies changing ownership and some going bankrupt. There are still more turbine manufacturers than the market can sustain. A few large multinational companies are involved in the wind industry; this is likely to increase as the world market grows.

5.2.4 Technical and Market Barriers

Despite falling costs, wind energy remains more expensive than conventional energy sources; therefore cost continues to be the most serious barrier to its further development. The wind industry will continue to rely on public support for the short to medium term. Perhaps the next largest barrier is the varying level of public acceptance of the visual impact of turbines. The drive to minimise costs led initially to the siting of many turbines on high ground where wind speeds are highest but the visual impact of turbines is greatest. Noise generated by wind turbines is another problem and a barrier to development close to homes.

Both of these barriers would be reduced by a better understanding of wind regimes and their interaction with wind turbines. Reducing technical uncertainties would give designers the tools to reduce the cost of turbines, to build turbines to operate at lower wind speeds (and thus on less visible sites) and to reduce noise.

5.2.5 Relevance for South Africa

The European wind energy industry is well-placed to continue its success in developing wind power within the EU. It should also concentrate some of its efforts towards manufacturing and marketing for wider markets. This could include the study of wind energy resources in South Africa, where there are different market conditions. The country has a reasonable wind resource which is mainly concentrated along the coastline and the Drakensberg Escarpment. There is a good potential for wind farms transmitting power through the national grid and for smaller units in off-grid applications.

While South Africa has little experience in modern large wind turbines, the technology could be readily imported from Europe.

5.3 Tidal energy

Tidal energy schemes exploit the natural rise and fall of coastal tidal waters to generate electricity.

5.3.1 The Technology

Tidal energy can be exploited in two ways: (1) by building semi-permeable barrages across estuaries with a high tidal range and (2) by harnessing offshore tidal streams. Barrages allow tidal waters to fill an estuary via sluices and to empty through turbines. Tidal streams can be harnessed using offshore underwater devices similar to wind turbines; tidal stream technology is in its infancy, with only one prototype 5kW machine operational in the world. Tidal energy is currently more expensive to generate than many other renewable sources.

5.3.2 Market overview

The exploitable tidal energy power in Europe is 105TWh/year from tidal barrages (mostly in France and the UK) and 48TWh/year from tidal stream turbines (mostly around UK shores). A 240MW barrage has been operational at La Rance in France since 1967. Both technologies are commercially unattractive at present and no further deployment is anticipated before 2010.

Figure 5.4 *Tidal Bar Energy Plant, France (Source: http://www.europa.eu.int/*

5.3.3 European competitiveness

Europe is the world leader in terms of experience in design, construction and operation of tidal barrages. Any future projects would be sizeable and long-term, involving civil engineering and equipment supply organisations with the financial strength and resources to undertake such work. SMEs would act as subcontractors, particularly in specialist areas such as environmental assessment. Several European organisations have experience in tidal stream technology and specialists within the EU have the expertise to evaluate and develop it.

5.3.4 Market Barriers

A number of technical barriers and market barriers impede deployment of tidal energy technology:

- Schemes are likely to be limited to areas such as France and the UK which experience high tidal ranges.
- Suitable funding is a problem: barrage deployment is capital-intensive with long construction and payback periods, while tidal electricity costs are greater than those for many other renewables and sensitive to discount rates.
- Tidal energy schemes affect the environment, influencing water levels, currents and sediment transport, and their construction also has local environmental effects - detailed environmental impact assessment would be needed if a tidal energy scheme were to proceed to full scale; on the positive side, barrages can improve infrastructure by providing crossing points (e.g. at La Rance) and may also enhance amenity values and increase tourism.
- Access and navigational changes caused by barrage construction might require changes to legislation.
- Tidal stream technology raises many technical problems (e.g. configuration, reliability, safe deployment and recovery, grid connection, operation and maintenance).

5.3.5 Relevance for South Africa

No relevant studies on the applicability of this tech have been identified, and that the technology is not ready even for countries strongly pushing RE The potential for the coast of South Africa should be assessed in a more detailed study.

5.4 Electricity generated by biomass

Biomass fuels are derived from four sources: forestry residues - as a by-product of timber and pulp production; agricultural residues - e.g. straw from cereal production; agro-processing residues - from crop processing; and energy crops grown specially for use as a fuel. These can be used to generate electricity in thermal power plant.

Figure 5.5 *Biomass Electric power plant in Spain (source: http://www.europa.eu.int/)*

5.4.1 Technology overview

Conventional combustion technology is expensive and has limited development potential for biomass electricity. Advanced technologies that convert the biomass to gas or liquid before combustion show the promise of lower overall costs. Co-utilisation with fossil fuels in an existing boiler is potentially the lowest cost option but is limited to use in areas with existing coal plant.

Substantial use of forestry residues within the EU is currently limited to Sweden and Finland, although there is scope for other EU countries to follow this lead. Agricultural residues are a difficult fuel to burn efficiently, but the technology is being developed and there is now some deployment, mainly in Denmark. Agro-processing residues are not an important resource in the EU, but represent an export opportunity for the power engineering industry.

Coppiced wood species, e.g. willow and poplar, are the most widely used energy crops. Other crops such as grasses that may have higher yields, especially in the more southern EU Member States, are being developed. Energy crops are important to the long-term strategy of the EU because they are the only biomass fuel that can be expanded sufficiently to significantly shift the pattern of EU energy supply. The use of wood residues in the wood processing industry is widespread and the equipment used can be considered mature.

5.4.2 The Market

Biomass fuel is available throughout the world. Wood residue, the dominant fuel, is readily available where there is an active forestry industry. For large-scale plant the high capital cost of conversion equipment usually makes biomass an expensive fuel; however, these plants have been developed where waste management measures were necessary in sawmills and pulp and paper industry. Financial incentives, including high taxes on fossil fuels and capital grants, have been critical for stimulating the use of biomass in co-generation plants for district heating systems.

In 1994, generation of biomass electricity in the EU was 11.9TWh. This is projected to increase to 27TWh in 2010 if appropriate measures are put in place. Total world-wide energy generation from biomass is currently 127TWh/year and is set to rise to 291TWh/year.

5.4.3 EU competitiveness

Since the inclusion of Finland and Sweden, the EU has been the market leader in electricity generation using biomass in conventional steam cycle power plant, and is moving towards the same position in advanced biomass technologies. The Nordic countries are dominant in forestry harvesting systems due to their strength in the timber, paper and pulp industries. The projected increase in biomass electricity generation in the EU represents some 2400MW_e of new plant in the period up to 2010.

5.4.4 Market barriers

The principal barriers to the further development of the biomass electricity markets are:

- lack of information for decision makers at different levels and the public in general, leading to a lack of understanding of the benefits of biomass for power,
- lack of integrated policies for achieving specific targets at EU and Member State levels, particularly between the agriculture and energy sectors,
- high capital and fuel costs relative to fossil fuels,
- a perceived high technical risk in most of the EU that makes finance expensive,
- considerable uncertainty about future European standards for atmospheric emissions,
- lack of information on the complex environmental issues related to biomass schemes; some environmental regulations have increased the cost of biomass systems while, at the same time, less stringent legislation has applied to fossil fuel systems;
- lack of farmers willing to plant energy crops, due to cost, uncertain profit etc;
- incentives are not co-ordinated - and experience of problems and advantages is not readily transferred - between countries;
- widely differing opinions on the merits of long-term fuel contracts between fuel supply companies and the power generation industry.

5.4.5 Relevance for South Africa

Given the readily available technology as a result of EU and other world-wide research efforts, and the abundant supply of biomass in South Africa, electricity generation by biomass is likely to have a prominent role in the energy supply at some time in the future.

5.5 Photovoltaic Energy

5.5.1 Overview of technology

Most commercial PV cells are manufactured from crystalline silicon, although research is identifying other suitable materials, some of which are now being marketed. The individual cells are grouped into modules and encapsulated between a sheet of glass and a backing material (also often glass) within a frame. Modules are then connected together to provide the voltage and current levels required to meet a particular load.

Figure 5.6 *Off-Grid rural application of PV in South Africa (Source: Renewable Energy World. January 2000)*

A complete PV system incorporates a wide range of other components, e.g. cabling, batteries and inverters. These ‘balance of system’ (BOS) components provide the necessary interface between the PV modules and the electricity distribution grid or other specific application.

PV systems are both reliable and environmentally friendly Furthermore, although costs have fallen, efficiencies have improved, and the more advanced crystalline silicon cells achieve efficiencies of more than 24% under laboratory test conditions and 15% in commercial applications.

5.5.2 Market overview

The market for PV power applications is essentially fourfold:
1. Consumer products, e.g. calculators and watches.
2. Stand-alone power systems for remote locations.
3. Building-integrated, grid-connected systems.
4. Large-scale, grid-connected power generation.

Of these, consumer products and stand-alone systems are particularly well developed, resulting in an annual world-wide PV deployment of about 375MW_p by 1995. This is expected to rise to 6300MW_p by 2010 of which 2000MW_p would be in Europe.

Figure 5.7 *Grid-connected PV application in Denmark (Source: Renewable Energy World, January 2001)*

Two markets offer considerable potential for the future:
Stand-alone systems can make an important contribution to rural development in developing countries, providing electricity for homes, schools, health centres, communications, and water pumping and purification. They can also contribute to development in grid-connected areas, particularly where grid supplies are unreliable. In Europe, too, where stand-alone systems are widely used for communications, cathodic protection, water processing and distribution, and the provision of electricity in isolated rural dwellings, the market potential is estimated to be $100MW_p$ - $200MW_p$ by 2010.

The main market emphasis in the developed countries of Europe, the USA and Japan is on building-integrated, grid-connected PV systems in which the PV modules double as architectural cladding elements, thereby helping to reduce system costs. The technology has already been successfully applied, usually with public support, and the aim now is to develop systems that are commercially viable in their own right.

5.5.3 European Competitiveness

European manufacturers of PV cells and modules - most of them big multinational companies - have traditionally held a strong position in world markets. In 1994, their share of the total was more than 31%. However, the recent move towards large-scale manufacturing to reduce costs has caused some of these companies to switch their production facilities to the USA. As a result, Europe's market share fell to 21% in 1996. This has significantly reduced the region's short-term export potential and weakened its position vis-à-vis its North American and Far Eastern competitors.

The production of BOS components, together with most design and installation activities, is mainly in the hands of SMEs. These companies, often supported by EU initiatives such as JOULE and THERMIE, have developed a range of high quality products and significant levels of expertise. Provided they have the ability to operate at the trans-national level, these companies are well placed to take advantage of expanding markets throughout the world.

5.5.4 Technical and Market Barriers

There are several technical and market barriers to the more widespread deployment of PV power in Europe and elsewhere:

- Limited understanding of the technology and its existing commercial potential.
- High initial costs and the difficulties of securing finance.
- The low apparent cost of conventional electricity.
- The high import charges often associated with export markets.
- The lack of proper standards for system components, design and installation.
- The lack of grid-connection regulations adapted to PV.

5.5.5 Relevance for South Africa

PV technology is relevant for South Africa in a number of ways. First, there is the important role that PV can play in off-grid applications, such as telecommunication, very remote signal applications and off-shore. PV has been the preferred technology for supplying isolated rural households, schools and clinics under the electrification programme. The same can be predicted for the concession areas.

5.6 Solar Thermal - Water & Space Heating

Solar thermal systems convert energy from the sun directly into heat through ‘passive’ systems, or gather the solar energy and transfer it to a working fluid to heat water or air in ‘active’ systems. Solar thermal installations are well suited to use as part of an overall energy conservation programme,. This section covers ‘active’ systems; ‘passive’ systems will not be discussed as they are part of the housing design sector

5.6.1 Technology Overview

Active solar thermal systems comprise equipment such as solar collectors, storage tanks, pumps, piping, controllers etc. Solar thermal applications can be characterised by the size of the installation:

Small-scale systems: solar collectors are placed on or integrated into the roof, facade etc of individual dwellings or buildings for their private thermal energy consumption - usually domestic water heating.

Large-scale systems: larger central arrays are combined or incorporated in group heating systems for the supply of multi-family buildings and/or district heating.

Solar domestic water heating systems can meet up to 60% of the water heating needs of typical households in Northern Europe and up to 90% of the water heating needs of households in Southern Europe.

Current installation costs are 1000-5500 € for a typical domestic system; the lower end of the scale relates to smaller and simpler systems commonly used in Southern Europe and the higher end characterises Northern European systems. The more expensive systems employ larger collector areas, high performance flat plates or evacuated tube collectors.

For climate-related reasons, prices of larger, more complex systems used in Northern and Central Europe will never fall as low as those used in Southern Europe. However, prices of the more complex and sophisticated systems are expected to continue to fall during the coming decade.

5.6.2 The Market

There has been a market for thermal solar heating systems in the EU for some 20 years. However, the present market is very small compared to the existing potential.

Figure 5.8 *Domestic Water Heaters in Israel (Source: Renewable Energy World. Mar 2000)*

In 1994, the EU had an estimated installed area of 4.4 million m^2 of glazed collectors and 1.2 million m^2 of unglazed collectors. The largest installed area is in Greece, with over 2 million m^2. Outside the EU, the largest installed collector area in the world is in the USA, with over 6 million m^2 already in 1994. Japan, Israel and Australia also have large installed areas and, in recent years, there has been an increase of installations in China. The expected deployment in the EU in 2010 is 20 million m^2 of collector area, while world-wide deployment is expected to reach 100 million m^2.

5.6.3 European Competitiveness

In most EU countries, around 90% or more of the home market is supplied by manufacturers from within that country. Companies in Greece, Germany and the UK are the largest exporters of collectors in the EU. Greece, the largest exporter within the EU, exported 60,000 m^2 of collectors in 1994. Japan and Australia are the principal world exporters.

Sales of glazed and unglazed collectors in the EU amounted to 0.5 million m^2 and 160,000 m^2 respectively in 1994. Germany, Austria and Greece dominate the EU market, sharing over 80% of the total sales of glazed collectors. The German market is the largest in the EU for unglazed collectors, followed by Austria and France. The solar heating industry throughout Europe is principally made up of SMEs, with only 26 companies in Europe employing more than 30 people each. There are in total a few thousand solar heating companies Europe-wide.

5.6.4 Technical and Market Barriers

The main barriers to the further adoption of solar thermal applications are the lack of legislation encouraging environmentally friendly energy systems and the fact that solar technology is not competitive with the energy services provided by the utilities.

The present generation of systems has proved to be reliable and systems usually have a lifespan of 15-20 years. However, there could be a perceived risk associated with the technical performance of systems, particularly in countries which have had experience of badly installed systems in the past. Improved information availability and marketing would help to combat this perceived risk.

In addition, a ‘Guarantee of Solar Results’ (GSR) scheme has been developed with support from the solar industry and the EC to combat the perceived risk of poor performance and to improve the quality of overall energy service provided. Under the GSR system, suppliers contract to compensate customers if the system fails to supply a designated minimum quantity of energy each year.

In some countries a relative lack of public awareness of available systems constitutes a barrier to their more widespread deployment. This could be addressed by information campaigns, both for the general public and for professionals. Limited access to funds also presents a barrier to solar water heating, which is characterised by a high initial investment.

The complexity and cost of different national testing and certification procedures are barriers to European trade in solar systems. New European standards have been developed since 1998 and will ensure a single quality level for consumers and help to overcome this barrier.

5.6.5 Relevance for South Africa

Solar water heating is not widely used in South Africa. One of the reasons for this is the small financial incentive that people find for investing in such a system. Only when a tax system promotes the use of Solar Water Heaters can the market fully develop. In other parts of the world, legislation has been used to encourage the development of solar water heating. The technology could be readily imported into South Africa and could help create jobs in manufacturing these systems. The potential for off-grid application of this technology is enormous.

5.7 Solar Thermal - Electricity Production

Solar thermal electricity generation systems collect direct sunlight in special focusing collectors and convert this into thermal energy, which is then used to generate electricity.

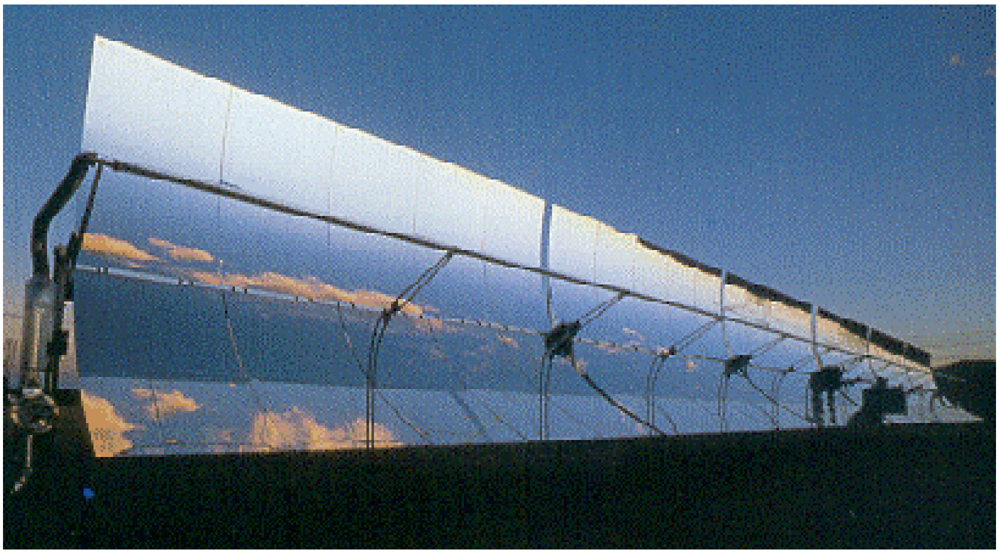

Figure 2.1 *Solar electricity production in California (Source:* http://www.europa.eu.int/*)*

5.7.1 Technology Overview

The generators in solar thermal electricity systems are driven by steam turbines or heat engines in the same way as conventional electricity generation. However, these systems are powered by concentrating the sun's rays rather than by combustion of fossil fuels or by nuclear heat. Solar systems use special focusing (rather than flat) reflectors to achieve the temperatures required to operate such systems efficiently.

Three main types of generator have been demonstrated, all of which require direct sunlight - solar systems are therefore most suitable for Southern European countries and non-EU countries with high direct solar radiation levels, often arid or semi-arid regions:

Solar farms use parabolic trough reflectors which focus solar radiation onto a line receiver containing the heat transfer medium in pipes. The medium, often a thermal oil (although once through water-steam systems are being investigated), is collected and passed through a heat exchanger where steam for the turbines is produced. Temperatures produced vary between 350°C and 400°C and system sizes are typically 30-80MW. To increase operating temperatures (and thus efficiency) as well as provide firmer power, steam from the solar system may be heated in a final stage by conventional fuels to higher temperatures.

Solar power towers use one central receiver mounted on top of a tower which is surrounded by a field of heliostats - concentrating mirrors which follow the sun. Reflected light is focused onto the receiver and absorbed by the heat transfer medium, which could be sodium, water, molten salt or air. Temperatures of 500-1000°C can be achieved and proposed systems also incorporate energy storage using molten salts. System sizes up to 200MW are possible.

Parabolic dish systems use parabolic concave mirrors which have a receiver mounted at the focus. These systems achieve the highest temperatures, 600-1200°C, but systems are small, 10-50kW for a single unit. The main application is decentralised electricity generation.

The technology's dependence on direct sunlight for efficient operation usually limits load factors to less than 25%. Ways of improving the load factor include designing plant, which incorporates energy storage (e.g. by passing the heated working fluid through a storage medium such as molten salts) or by combining solar thermal electric plant with conventional generation in a hybrid system.

5.7.2 The Market

Solar thermal electricity generation is still at the development stage and is not yet ready for commercial deployment without assistance. The most developed system is the solar farm concept, and several farms generating up to 80MW have been demonstrated in California, where the total installed capacity is now around 350MW. In Europe the technology has been applied only as prototypes. Solar towers have been developed at sizes up to 10MW and, while parabolic mirror systems have been tested in several countries (at up to ~50 kW) the technology is still under development. By 2010, the predicted potential for Europe is ~0.5 TWh/year, whilst that for the world is approximately 4TWh/year.

There is no commercial deployment of solar thermal electricity generation in Europe. Given the scale of investment required, a maximum potential deployment of the technology within the EU is estimated at some 300MW by 2010. There is potential for systems in Greece, Italy, Portugal and Spain to generate 1 TWh a year. World potential deployment could be up to 3000MW by 2010.

5.7.3 European Competitiveness

The EU has an established research community for solar thermal electricity systems, including university departments as well as some large commercial organisations and industries, particularly in Germany. As it nears commercialisation, the technology is likely to involve larger companies, with SMEs as subcontractors.

If an export market for the technology emerges, the likely market areas will be Northern and Southern Africa, Western Australia, California, the Middle East, Asia and parts of Latin America. However, the established US industry would provide a challenge to EU companies in a competitive market.

5.7.4 Technical and Market Barriers

The main barriers to the use of solar thermal electricity generation are financial, so the costs of the technologies need to be reduced and technology risks minimised. Perhaps the highest cost reduction potential lies in the integration of solar systems with conventional power generation.
The investment required for a 100MW plant - up to 250 million € - is too large to be considered under existing national funding programmes.

5.7.5 Relevance for South Africa

At present, the cost effectiveness of grid connected solar thermal power production, even in South Europe, is considered to be barely sufficient for commercial development. However, European technological know-how can be exported to sunnier places, like South Africa. European engineering companies are involved with several large international solar thermal projects, the 2.5 million square meters of parabolic trough mirrors, used in the solar electric generating plants in California, were manufactured in Germany. This is an example of a project that should be of comparable feasibility in South Africa.

5.8 Small-scale Hydro

Although many Hydro applications concern large project, in this chapter, we will only discuss projects below 1 MW. In terms of installed capacity and energy yield, hydro-electric power is the foremost electricity-producing renewable energy technology in Europe and world-wide. In the EU, most of the sites which are suitable for large-scale schemes have already been developed, and work therefore now concentrates on small-scale schemes.

5.8.1 Technology overview

Small-scale hydro schemes are typically defined as having an installed capacity of less than 10MW. They generate electricity by converting the energy available in flowing water (rivers, canals or streams).

Schemes require a suitable rainfall catchment area, a hydraulic head, a pipe or millrace carrying water to the turbine and a turbine house containing power generation and water regulation equipment. Water is returned to its natural course after it has been used. The technology is commercially and technically mature. Innovations in design, equipment and control/instrumentation would improve performance and increase access to export markets, as would systems to mitigate environmental impact.

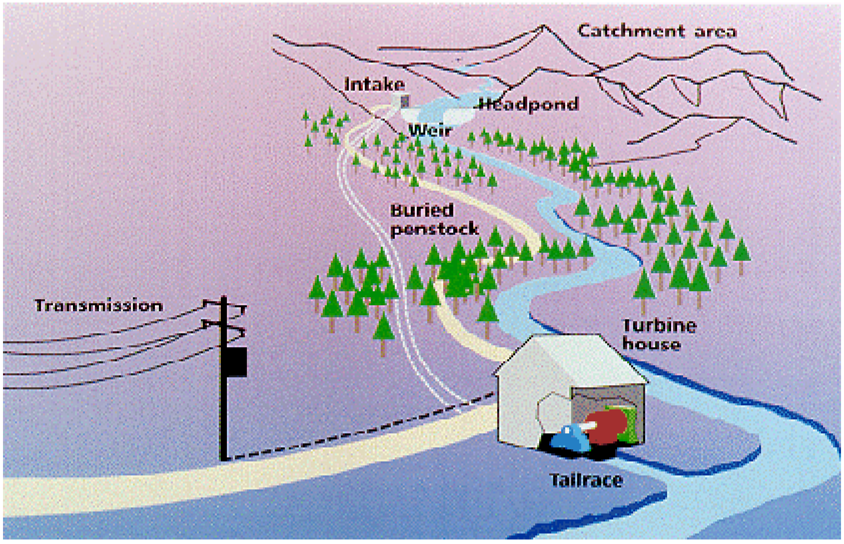

Figure 5.9 *A typical micro-hydro scheme (source: http://www.europa.eu.int/)*

5.8.2 The market

Figures for the 15 EU countries indicate that small-scale hydro schemes totalling 33TWh a year (8000MW) were operational in 1995. EU figures are expected to reach 45TWh a year, (9500MW) by 2010, with Spain, Italy, Sweden, Germany and Austria experiencing most growth.

The economically viable world hydro potential is around 7300TWh a year, of this 32% has been developed, 5% of it at small-scale sites. Small-scale hydro deployment world-wide is increasing at about 900MW annually and is expected to reach 220TWh per year (55,000MW) by 2010. Rapid expansion is expected in Asia, Latin America, Central and Eastern Europe and the former

Soviet Union. Countries within the EU/EFTA and NAFTA are expected to concentrate on upgrading/refurbishing existing hydro power assets rather than developing new capacity.

5.8.3 European competitiveness

The EU occupies a leading position in the world market, with a multi-disciplinary and highly skilled small-scale hydro industry employing about 10,000 people. Annual turnover exceeds 400 million €. Small companies and multinational organisations are represented. The industry offers the full range of products and services required for development of small hydro projects. Very little equipment is imported from outside the EU. Around 75% of the 900MW of new small hydro capacity added annually world-wide, most of it in developing countries, is accounted for by European companies. Competition comes principally from India, Canada, the USA, China and Japan.

Although the technology is particularly suited to SMEs, which currently account for a high proportion of activity in the small hydro sector, these organisations often lack the resources to enter export markets where most growth is expected. They may need help with marketing, promotion, finance and credit guarantees.

Very few governments within and outside the EU are offering incentives to increase small hydro deployment. Projects involve significant capital expenditure and typical payback periods of ten years. Such investments do not easily attract private finance without incentives (e.g. premium price electricity purchase contracts). A key development issue is the need to get project appraisals in place quickly, preferably through a single approvals body.

5.8.4 Technical and Market Barriers

The main barriers to the further deployment of small-scale hydro technology are:

- complex and lengthy administrative procedures,
- lack of understanding of hydro schemes among consenting authorities and the financial community,
- the requirement, in many countries, for an environmental impact assessment to be carried out for small-scale hydro proposals; these assessments cover a range of issues, e.g. fishery protection, river ecology, water quality and turbine noise,
- the lack of a universally adopted method of determining an acceptable minimum river flow,
- technical, resource and commercial risk involved in hydro development.

It should be noted that the cheapest schemes to develop tend to be in mountainous areas, although the best sites have already been exploited and environmental sensitivity is an important factor in those remaining. Low head schemes, by comparison, are often close to population centres, where the grid is strong and the rivers ponded or polluted, with consequently less environmental objections. Particular potential exists in terms of modernisation/refurbishment of existing or dormant sites.

5.8.5 Relevance for South Africa

Micro hydropower is mature technology with very limited scope for technical improvement. Developments are very site specific and there are increasing environmental concern regarding the construction of major new schemes. There is more scope for developing smaller schemes (under 10MW), including run-of-river schemes. A large potential has been shown recently in among others, the Eastern Cape Province (CSIR et al., 2000). Unlike many other renewable energy sources, hydropower is usually continuous and often has some element of energy storage built in.

There are an estimated 8000 potential sites of up to 100MW mainly in the eastern parts of the country. Development of these could clearly make a very useful contribution to the countries energy supply.

6. EUROPEAN INITIATIVES IN RENEWABLE ENERGY

6.1 Background

Within the European Union (EU) oil is the major source of energy followed by gas and coal. The use of nuclear and coal power are in decline. Gas consumption is increasing rapidly as more is imported from the former Soviet bloc countries.

All of the countries in the EU are committed to developing their Renewable Energy (RE) resources. Environmental aspects, linked to national greenhouse gas reduction targets, are the main motivation for governments to promote RE, together with energy supply security. There is a commitment following the Kyoto conference to reduce the emission of greenhouse gases 8% by the period 2008-2012 relative to their levels in 1990. Other important factors include job creation and the increasing competitiveness of renewable energy sources.

In 2000 the European Commission published a draft directive proposing renewable energy targets for 2010 for the member states. Figure 6.1 below shows these target figures together with the actual renewable energy contribution for the year 1997. As can be seen from this figure, there is a wide variation across Europe. The figures proposed are in line with the commitments made by the various member states and if implemented will raise the renewable energy contribution to 23%.

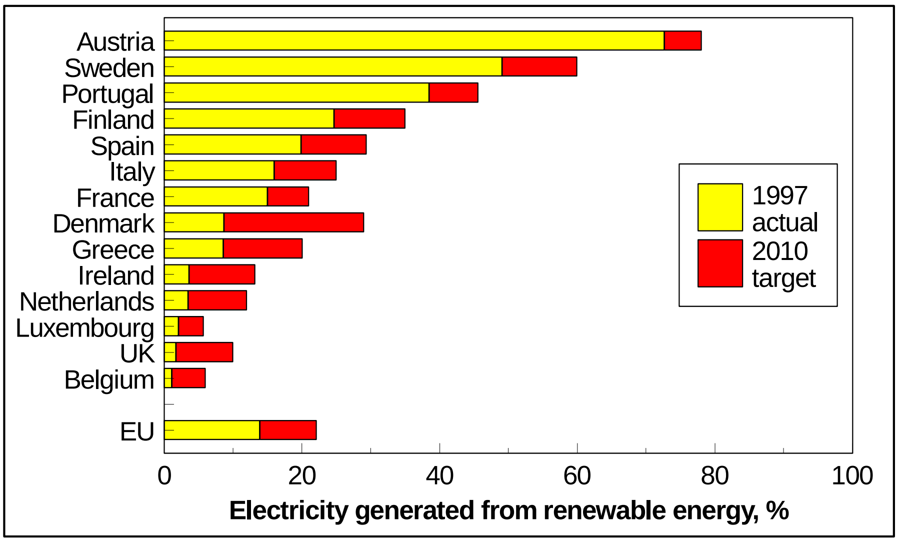

Figure 6.1 *Renewable energy: share of electricity use - existing and proposed - in the EU*

Currently renewable energy accounts for around 6% of European total energy usage and 15% of electricity consumption. The pattern of renewable energy usage varies widely across the EU and is mainly determined by geographical factors. Biomass is used in the form of forestry waste products in the northern countries where there are abundant resources. Hydropower[7] has been in use for many years and accounts for 30% of the total. It is well developed in the areas where mountains and rainfall permit. Wind is undoubtedly the fastest growing renewables sector.

[7] Large-scale hydropower is not considered renewable.

As can be seen from Figure 6.1, progress has been made in encouraging the development of RE. To achieve this the Member States have used a wide variety of incentive schemes. If the ambitious targets set by the Kyoto Protocol are to be achieved then this process will have to be accelerated. In 1998 the European Commission initiated a 'Survey on Renewable Energy Policy, Plans and Programmes in EU Member States and Norway'. This involved the member states completing questionnaires submitted to them by the European Commission. This section of the report draws heavily on this survey which was completed in 1999 as well as on Kühn et al. (1999), Schaeffer et al. (1999). Detailed information on EU-wide and Member State RE policies can be found on the following website: http://www.agores.org.

6.2 RE Support Strategies

In order for industry to invest in renewable energy, there has to be a reliable favourable long-term financial framework in place. This requires governments to set targets and to identify and remove any non-technical barriers. Most EU governments now have RE as part of their national policy and have developed and published promotion strategies. These are listed in Table 6.1. Given the high level of attention that this subject is attracting, Member States are reviewing their policies and targets on a regular basis.

Table 6.1 *RE Policy Documents and National Targets (1998)*

Country	Coherent RES Policy Paper (National Plan, White Paper)	Targets ('96-'99)
Austria	'Energiekonzept der Bundesregierung'	No national, but regional targets
Belgium	Wallonia: 'Strategie de Promotion des Energies Renouveables' under preparation	*Wallonia*: No targets. Forecast: 5 to 6% by 2010 ('ambitious', actual share 1.2%); *Flanders*: Doubling RES by 2000, 3%RES share in energy consumption by 2010, 5%by 2020
Denmark	'Energy 21': comprehensive reform package on energy legislation under preparation	Wind: 1,500 MW land based before 2005; 4000MW off-shore before 2030; biomass: 60% increase from 1995 to 2005; linked to CO_2 reduction targets
Finland	Only sectoral programmes	High share already now: 19% of total energy consumption (biofuels, without peat); increase of bioenergy of 27% (1994-2005)
France	Only sectoral programmes and targets	No national target : EOLE 2005 target is being modified
Germany		No national targets; forecast:2.5 to 3% by 2020; regional targets in some federal states
Greece	Action plan '2001'	Objective: Increase of RES share in national energy balance from 5.4% to 8.5% in 2010 mainly via wind and biomass (linked to reduction of $C0_2$ emissions targets)
Ireland	'Green Paper on Sustainable Energy' under preparation	Will be considered in the context of the Green Paper
Italy	National White Paper on RenewabIe Energies (to be approved 1999)	Doubling of RES contribution to the energy balance by 2010; linked to greenhouse gas reduction targets
Luxembourg	'Plan National de development durable likely to be valid from 1/99 on	
Netherlands	Third White Paper on Renewable; 'Renewable Energy - Advancing Power': Action Programme for 1997-2000	Around 3% of energy demand from RES, 10% by 2020
Portugal	'Program Energia'	180 MW by the end of 1999 (RES electricity; within the Energy Programme)
Spain	'Plan de Fomento de las Energias Renovables'	White Paper: 12% of energy demand by 2010 to be covered by RES
Sweden	Bill on a Sustainable Energy Supply (June 1997)	
UK	New and renewable energy policy review, under preparation	10% of electricity demand by RES by 2010

6.3 Motivation for RE

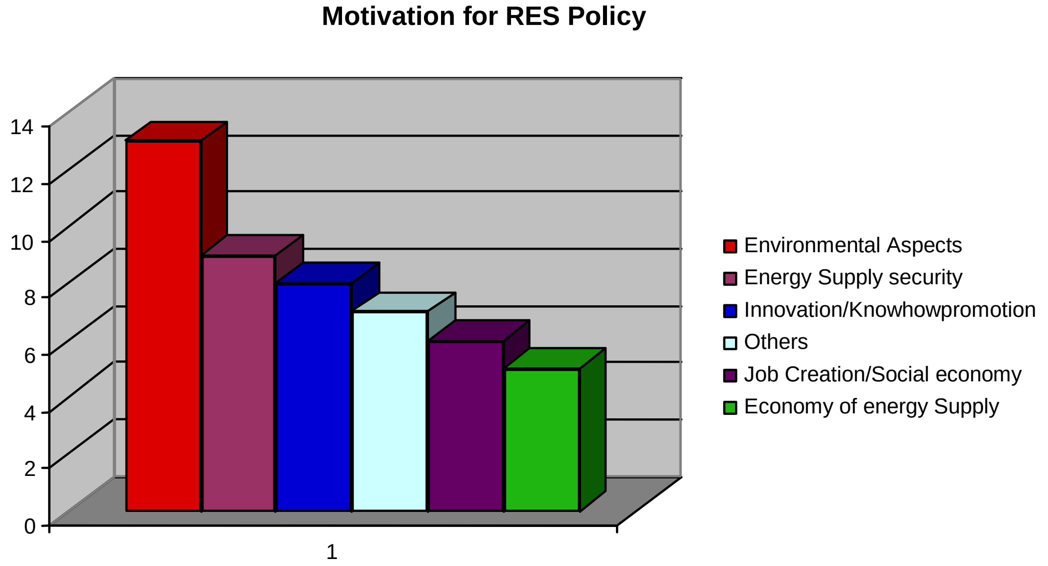

Figure 6.2 *Motivation for RES* Policy

The survey concluded that the main object of European governments for favouring renewable energy is to achieve sustainable, environmentally sound energy supply. This was the case for all EU countries with the exception of France and Belgium, which are both heavily dependent on nuclear power. The second important reason was that as RE resources are indigenous they can be considered to increase security of supply. Job creation effects and improvement of economy of energy supply were also seen as being important. Fig.3. tabulates the responses given to the questionnaire.

6.4 Renewable Energy Support Mechanisms in the European Union

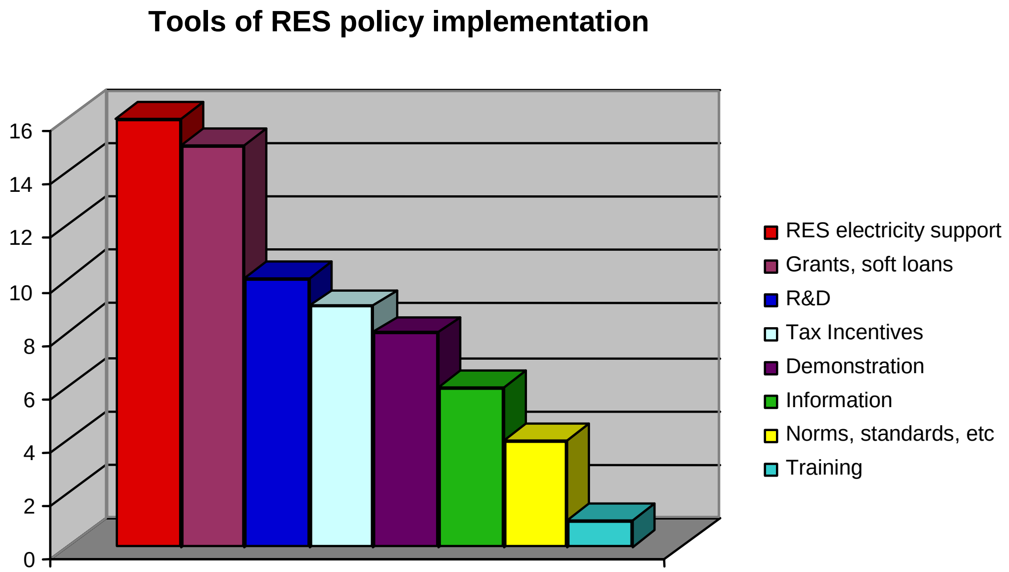

Figure 6.3 *Tools for RES Policy Implementation*

The focus in this paragraph is on economic support mechanisms for RE in the EU. Economic RE support mechanisms in the EU are mainly quota based systems, such as tradable green certificates and tendering systems, and direct price support mechanisms, such as feed-in tariffs and subsidies. Moreover, fiscal measures that seek to internalise the cost of environmental pollution can be employed to improve the competitive position of renewable electricity generation.

There is a wide range of renewable energy technologies: some provide electricity, others heat. Some are small-scale and decentralised others are in the multi-MW-range. Some are economically competitive; others still need - apart from niche market applications - additional support. Some are ‘classical’, others still in the experimental stage. This diversity needs flexible ‘tailor-made’ promotional instruments and the survey clearly show that Member States are generally looking for packages of appropriate instruments.

All national surveys of Member States indicate that independent power production is necessary for ‘green’ electricity to be injected into the grid. All the Member States mention special, favourable tariffs for electricity generated from RE. The approaches, however, vary greatly. Such tariffs may be subject to competition, may be mandatory on utilities at a price level fixed by the government, or may be the consumer's choice. Tariffs may also vary in relation to the energy source in question (higher for PV, lower for wind, biomass and small hydro).

Governments generally consider electricity feed-in tariffs alone as not sufficient to trigger wide-scale RE dissemination, and therefore provide additional assistance in form of grants, low-interest loans, or tax incentives. Such support may be given for RE producing heat (solar collectors, firewood, biofuels). Likewise, electricity generating RE considered not yet economically competitive or to balance less favourable boundary conditions (e.g. wind in off-shore areas).

Renewable energies are a classical field for research and technology. Ten of the surveys received explicitly mention national RTD programmes. These are mainly limited to institutional support to research centres and universities but also include programmes for the support of individual projects. RTD programmes generally focus on the RE offering the largest national potential. Photovoltaics is considered by many to be the sector offering the greatest cost reduction potential via technological innovations.

In nine responses, demonstration projects were identified as being a good means to bridge the gap between lab-scale or pilot plants (as the result of an RTD project) and large-scale implementation.

Technology and investment-related support measures are usually accompanied by actions addressing legislation and standardisation. Information and advice to potential consumers as well as professional training activities are also required.

6.4.1 Subsidies

The most widespread instrument to stimulate RE sources has been subsidies. Subsidies are used mainly for two purposes, stimulating the development of RE technologies and enhancing the competitiveness of RE technologies in the market. The latter can generally be divided into subsidies on RE capacity and subsidies on renewable electricity generation. Subsidies on capacity only stimulate capacity instalment, but do not stimulate generation and the demand for renewable electricity. To stimulate the development of less economical RE technologies, such as rooftop photovoltaic systems, higher subsidies are required than these given for technologies that are closer to the market, such as wind.

Uncertainties in subsidy schemes arise from budgetary issues, and the administrative process by which they are established and allocated. For instance, subsidies on installed capacity might be unfairly distributed if the total amount of subsidy is limited. In general, if the subsidised technology becomes too widespread, the subsidy may have to be abolished because of the high cost. These issues are particularly sensitive if the total subsidy budget is subject to annual government appropriation.

6.4.2 Feed-In Tariffs

Feed-in tariffs are a special case of subsidies on renewable electricity generation. They come in the form of guaranteed premium prices in combination with a purchase obligation by the utilities. The levels of guaranteed prices and the basis on which they are established varies considerably from country to country. In several countries the feed-in tariff is based on the avoided cost of the utility that has the purchase obligation. Furthermore, the tariff can be differentiated according to season, time-of-day, and continuity of supply.

The German electricity feed-in law (Stromeinspeisungsgesetz) provides for a fixed price for all renewable generators. Grid operators are obliged to accept renewable electricity produced in their area at the fixed feed-in price. To protect the grid operators against high financial loads, a toughness condition is included in the law. A regional limit of 5% renewable electricity is set. If the renewable electricity production surpasses this threshold in a supply area, the operator is exempted from the obligation to purchase and refund.

Feed-in tariffs have proved to be very successful in promoting the deployment of renewable energy sources. However, utilities that are located in areas with a large potential of renewable energy sources will likely be offered more renewable electricity, and will therefore have to pay more premium tariffs. In a liberalised electricity market this puts these utilities at a competitive disadvantage relative to utilities in areas with low renewable energy potentials. Some kind of compensation mechanism could be designed to avoid this problem.

In the short term, fixed feed-in tariffs give maximum investment security to RE developers. However, as the contribution from renewable sources to the generation mix increases, the cost of a fixed feed-in tariff system would become to high in the longer term, and political support for the system will diminish. Thus the long-term investment security is low because of the inherent political instability of the system.

Contrary to competitive market-based support mechanisms, such as tendering systems and green certificate trading systems, fixed feed-in tariffs do not provide incentives for innovations and cost reductions. To counter this deficiency the appropriate regulatory authority may lower the fixed tariff to reflect falling prices caused by technological and operational progress. However, this may be resisted by existing renewable electricity generators.

6.4.3 Tradable Green Certificates

Rather than stimulating supply of electricity from RE, a green certificate system seeks to stimulate the demand. The green certificate system is based on the separation of electricity as a physical commodity, and its 'greenness' emanating from the use of renewable sources. The 'greenness' is incorporated in the green certificate, which is issued at the moment of production, and which can be traded separately from the physical commodity. Certification provides an accounting system to register production, authenticate the source of electricity, facilitate trade, and to verify whether demand has been met. Demand may be voluntary, based on the customer's willingness to pay for green electricity, or it can be imposed by the government. In the latter case, penalties are applied if the demand obligation is not met.

The principle advantage of trading in green certificates is that it provides a cost-effective means of achieving a RE generation target. Furthermore, the level of ambition of the target or obligation is reflected in the price of the green certificates. This can provide a clear price signal to potential investors in RE projects. Moreover, green certificate trading stimulates competition between RE producers, which will lead to declining costs of renewable electricity generation.

The critical issues in the design of a green certificate trading system are the definition of renewables to be used, the timing aspects of the obligation, the penalty for not reaching the target and the parties bearing the demand obligation. With regard to the timing aspect, the targets, the window for meeting the obligations and the time validity of the certificates should be determined. Moreover, the number of years that the demand obligation will be in force affects the uncertainty faced by RE project developers.

Green certificates can be traded, banked and consumed like any other commodity. In several EU Member States they are predominantly traded through bilateral contracts, but it is expected that both a spot market, and a forward and options market to hedge against price risks, will develop for green certificates. Forward prices will provide a powerful price signal for the development of new RE projects.

Green certification systems have only recently been introduced in the Netherlands, Denmark and Belgium. In the Netherlands the system and demand obligation is currently based on a voluntary agreement between all electricity producers. The certificates are only valid in the year in which they are produced. The price is therefore very sensitive to annual weather variability. Furthermore, as most certificates are traded bilaterally, the market is not very transparent. Only a small fraction (3%) of the certificates is traded through the spot market. The relatively small number of market players in the Dutch electricity market does not encourage the development of the spot market. This reduces the investment incentive that green certificates can provide. Moreover, it poses a problem for determining the penalty rate. Currently the penalty rate is defined as 150% of the average annual certificate market price. This has the benefit of not putting a cap on certificate prices. On the other hand it is hard to determine a representative average market price if most trades are bilateral.

6.4.4 Tendering Systems

In tendering systems a limited subsidy on output is awarded to a restricted number of investors. Potential investors have to compete for this subsidy through a competitive bidding system. In each bidding round only the most cost-effective offers will be selected to receive the subsidy. The bidding may be differentiated in bands of different technologies and RE sources. This means that wind projects compete against other wind projects but not against, for example, biomass projects. The marginal accepted bid sets the price for the whole technology band. The government decides on the desired level of electricity from each of the renewable sources, their growth rate over time, and the level of long-term price security offered to RE generators over time. The bidding is accompanied by an obligation on the part of electricity providers to purchase a certain amount of electricity from renewable sources at a premium price. The difference between the premium and market price is reimbursed to the electricity provider, and is financed through a non-discriminatory levy on all domestic electricity consumption.

The UK has a tendering system known as the Non-Fossil Fuel Obligation (NFFO). The NFFO obliges the Regional Electricity Companies (RECs) to buy a certain amount of renewable electricity at a premium price. These specified amounts are met with NFFO contracts that are awarded as a result of competitive bidding within a technology band on a pre-arranged date. The cheapest bids per kWh within each technology band are awarded contracts. The NFFO generators are paid the premium price per kWh. The Non-Fossil Purchasing Agency (NFPA), a wholly owned accounting body of the RECs, reimburses the difference between the premium price and the pool selling price to the RECs. This difference is paid for by a Fossil Fuel Levy on electricity, paid for by all electricity consumers.

The NFFO has been very successful at bringing down the price of renewable electricity. Since 1990 five tendering rounds have been held, NFFO-1 to NFFO-5. From NFFO-3 to NFFO-5 the average price of renewable electricity has dropped by almost 40%. The average bid price under NFFO-5 was only about 0.02 €/kWh above the reference market price for bulk electricity supply.

Depending of the duration of the contract offered to the RE generator, a tendering system gives more or less revenue security in the long term. Long term obligations, accompanied with long term contracts increase revenue security and can lower the cost of finance of RE projects.

The cost to RE project developers of preparing for a bidding round is significant, with a high risk of being declined. This high up front risk will lead to larger companies being the main bidders, rather than small local enterprises.

From the government point of view tendering systems may have several advantages. Tendering in technology bands allows taking other interests into consideration, such as stimulating domestic industry, local employment and the country's export potential.

6.4.5 Fiscal Measures

Several EU countries support renewable electricity via their tax system. The form of these schemes may range from rebates on general energy taxes, rebates from special emission taxes, proposals for lower Value Added Tax (VAT) rates, tax exemption for green funds, to fiscal attractive depreciation schemes. In these countries the gap between renewable and non-renewable electricity cost has declined. However, because of considerations of international competition these taxes have never been put at such a level that they contribute substantially to the deployment of RE sources. Harmonisation of green tax systems across the EU would be needed to avoid this problem.

6.4.6 Overview of European Union Renewable Energy Support Mechanisms

Most EU Member States employ several policy instruments in parallel to promote the generation of electricity from renewable sources (see http://www.agores.org and http://www3.jrc.es/projects/eneriure). Table 2 lists the main and additional policy instruments per Member State. It should be noted that, in addition to specific RE policies, other policies, such as grid access and tariff regulations or local spatial planning procedures, may also be very important to the development of the RE projects. Both often impose significant barriers to RE project realisation.

Another aspect that deserves some attention is the quality of the installed equipment. RE technology often has to meet certain safety requirements. These can be technology specific, as is the case for wind turbines, or they can coincide with sector or industry codes, such as building codes for the integration of photovoltaic systems in rooftops. There are no requirements concerning the operational quality of the equipment, such as the amount and reliability of output and the conversion efficiency. Incentives to maintain and increase operational performance can be tied to the support mechanism that is used. Subsidies on output provide a strong incentive to improve operational performance, since the amount of subsidy is directly proportional to the output that is generated. Support mechanisms that are based on competitive mechanisms, such as tendering and tradable green certificates, also reward RE generators for maintaining and improving continued generation, reliability and efficiency. Moreover, competitive mechanisms provide an incentive to reduce the cost of renewable electricity generation at the same time.

Table 6.2 *Overview of renewable energy policy instruments per EU Member State*

	Investment subsidy	Feed-in tariff	Tender	Fiscal or tax	Green certificates
Austria	o	+	o		
Belgium		o		o	+
Denmark		o		o	+
Finland	+			o	
France	+	o	o		
Germany	+	+			
Greece	+	+		o	
Ireland	+		+	o	
Italy		o		o	
Luxembourg		o			
Netherlands	+			o	+
Portugal		o			
Spain		o		o	
Sweden	+	o			
UK			+		

+ = main instrument
o = additional instrument

6.5 European Union Export Subsidies for the promotion of Renewable Energy

6.5.1 European Union, General

New and renewable energy sources
The European Investment Bank finances investments[8] of European companies in, amongst others, Renewable Energy projects to a maximum of 50%. The receiver of the loan is fully responsible for the implementation and the organising of sub-contracts.

Not especially applicable to renewable energy, but nevertheless relevant, is the European Community Investment Partners programme. This programme stimulates the set-up of joint ventures between SMEs in The Netherlands and South Africa.

[8] See also: www.evd.nl

The ECIP programme has five facilities:

1 identification of partners and projects,
2 privatisation and private sector infrastructural investments,
3 Feasibility studies,
4 Financing of joint ventures,
5 Human resource development. Applications for this financial facility can be sent to major banks in The Netherlands and South Africa.

6.5.2 Country specific export stimulation measures

Belgium (1998 Country Report On Economic Policy and Trade Practices[1])

There are no direct export subsidies offered by the government to industrial and commercial entities in the country, but the government (both at the federal and the regional level) does conduct an active program of trade promotion, including subsidies for participation in foreign trade fairs and the compilation of market research reports.

In addition, exporters are eligible for a reduction in social security contributions by employers and benefit from generous rules for cyclical layoffs. The latter programs -- known as Maribel -- come close to the definition of an export subsidy, and have already been denounced as such by the European Commission. All of these programs are offered to both domestic and foreign-owned exporters.

Denmark (1998 Country Report On Economic Policy and Trade Practices[9])

The government does not directly subsidise exports by small and medium size companies. Denmark does, however, have programs which indirectly assist export promotion and establishment of export networks for small and medium sized companies, research and development, and regional development aimed at increasing exports.

Germany (1998 Country Report On Economic Policy and Trade Practices[1])

Germany does not directly subsidise exports outside the European Union's framework for export subsidies for agricultural goods. Governmental or quasi-governmental entities do provide export financing, but Germany subscribes to the OECD guidelines that restrict the terms and conditions of export finance.

The Netherlands [10]

The Netherlands has programs for the promotion of pilot projects, demonstrating the use of renewable energy. There are hardware subsidies available for a small number of systems or components. Furthermore, there are investment subsidies available up 800 k€ under the so-called PSOM programme. The so-called PESP programme funds feasibility studies that are necessary to prove an export opportunity of Dutch hardware. A minimum amount of 60% value added has to be generated in The Netherlands.

Next to this, there are specialised innovation-type of projects fundable under the so-called BIT programme. This programme is aimed at, amongst others, South Africa. There is an export subsidy available for environmentally friendly products that currently are not commercially viable. This subsidy, called ORET/MILIEV can also be used to promote export to a country like South Africa.

Furthermore, there is a programme to stimulate the technological co-operation between South African and Dutch companies and research institutions. The accent lies on the establishing of contacts, the broadening of networks and the set up of concrete co-operation projects. This fund

[9] Country Library (http://www.tradeport.org/ts/countries/) The source is the U.S. Department of Commerce.
[10] http://www.senter.nl/ www.novem.nl

was not installed especially for renewable energy purposes, but could potentially be used for joint development of renewable energy projects and local adaptation of existing technologies.

The Joint Implementation Facility is a programme that is specifically targeting the reduction of greenhouse gas emissions. There is a subsidy available for investments that contribute to the decrease of CO_2 emission. When a South African business utilises Dutch technology or a Dutch enterprise utilises South African technology to decrease CO_2 emissions, a subsidy can be applied for.

Lastly, there are a number of general financial facilities aimed at promoting exports from The Netherlands to South Africa. More information on these facilities can be found at the Department of Trade and Industry in South Africa.

Spain (1998 Country Report On Economic Policy and Trade Practices[5])
Spain aggressively uses ‘tied aid’ credits to promote exports, especially to Latin America, the Maghreb, and more recently, China. Such credits reportedly are consistent with the OECD arrangement on officially supported export credits[11].

The Spanish Government offers a variety of instruments to support exports.
- Development Aid Fund (FAD): The Spanish State uses this fund to offer concessional loans to developing countries. The loans however are bound to Spanish goods and services.
- Fund for Feasibility Studies (FEV): This fund finances feasibility studies of projects. The studies must be performed by Spanish consulting companies and the projects must have potential for the Spanish exporting sector. The financing is organised by means of donations to beneficiary governments or by co-financing the studies.
- Export Credit Insurance: Its purpose is to cover political risks, irrespective of the term, and commercial risks beyond 3-years terms. The insurance is operated by the Spanish Export Credit Insurance Company (CESCE).
- Agreement on Reciprocal Adjustment of Interest Rates (CARI): This is a interest rate stabilisation system by which Spanish exporters can transform variable interest rates, as available on the financial market, to fixed interest rates for their foreign clients. Some Autonomous Communities have systems of their own for exporters located in their territory.
- Initiation Plan for Foreign Promotion (PIPE 2000): The plan is run by the Spanish Foreign Trade Institute (ICEX), jointly with the Council of Chambers of Commerce and the Autonomous Communities. It offers tutorial support to small and medium enterprises in their initial efforts in the foreign markets.

6.5.3 Conclusions
Several economic RE support mechanisms are currently used in various EU Member States. These support mechanisms can be distinguished in competitive quota-based mechanisms, i.e. tendering and tradable green certificates, and non-competitive subsidies and feed-in tariffs. Furthermore, support may be targeted towards RE capacity or RE generation. Support mechanisms that reward a RE generator for its generated output provide a strong incentive to maintain and improve operational performance and to increase the generator’s output. This is preferable to capacity support if a government seeks to increase the share of electricity from renewable sources in the overall generation mix. Output subsidies and feed-in tariffs, however, can become very costly as the renewable electricity generation increases. Contrary to output subsidies and feed-in tariffs, quota-based mechanisms stimulate competition and thereby provide a strong incentive to reduce the cost of renewable electricity. Furthermore, fiscal instruments can be employed to reduce the cost differential between renewable and non-renewable electricity genera-

[11] Plan for the promotion of renewable energies in Spain, December 1999.

tion. In practice most EU countries use more than one support mechanism at a time. In addition to economic policy support mechanisms several other policies, such as grid access regulations, safety regulations, building codes and spatial planning procedures, play an important role in the implementation of RE projects.

7. CLIMATE CHANGE SUPPORT MECHANISMS FOR RENEWABLES

Growing scientific evidence that human activities are inducing changes in the climate started a process to adopt an international treaty to address the problem. The United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992 with the aim to stabilise greenhouse gas concentrations and thus avoid dangerous interference with the climate system. Many of the original signatory countries have ratified the Convention and additional states have acceded.

All parties to the Convention committed to prepare inventories on emissions and removals of greenhouse gases. In addition, developed (Annex I) parties committed to return their emission of greenhouse gases to 1990 levels by year 2000, and to finance the costs incurred by developing (non-Annex I) parties in complying the obligation mentioned in first place.

Article 4, Paragraph 5 of the Convention is especially relevant to the implementation of renewable energies in developing countries through climate change-related initiatives. This paragraph states that parties included in Annex II (i.e. developed parties excluding countries with economies in transition) ‘shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention’. The European Economic Community (nowadays European Union) and all its member countries are Annex II parties (UNFCCC, 2000a).

7.1 UNFCCC financial mechanism

The Convention established a financial mechanism, served by the Global Environment Facility (GEF), for the provision of grant or concessional funds to meet the agreed incremental costs of activities addressing climate change in non-Annex I parties. Funds come from more than 30 Annex I countries, including the EU and its member countries.

The GEF Operational Strategy on climate change sets out the financing for enabling, mitigation, and adaptation activities, defined as follows. Enabling activities facilitate implementation of country commitments to the Convention. Mitigation measures reduce emission of greenhouse gases or enhance removal of such gases by sinks. Adaptation activities minimise the adverse effects of climate change (GEF, 1996a).

As of May 2000, the GEF had four operational programs in climate change, one of them (Program 6) aimed at promoting renewable energy (GEF, 1996b). Its objectives are to remove the barriers to the use of commercial or near-commercial RETs, and reduce any additional implementation costs stemming from a lack of practical experience, initial low volume markets, or from the dispersed nature of applications. The market applications initially identified are listed below but other commercially viable applications may be considered.

- wind pumps for mechanical water pumping for agriculture and domestic water supply,
- low-temperature solar thermal heat for household and agricultural sectors,
- biomass and geothermal heat, including combined heat and power, and use of urban and industrial wastes for process heat and district heating,
- wind, biomass, photovoltaics, small-scale hydro, and other renewable energy for rural electricity supply,
- renewable energy for grid-connected electricity (e.g. wind farms),

- storage systems (e.g. batteries) for cost-effective but intermittent renewable energy supplies, and
- biogas digesters for lighting and water pumping (family-size digesters for home lighting and cooking; community-size digesters coupled with engines and electric generators for water pumping, lighting, and village power needs).

Those cases where RE are not yet cost-competitive with conventional energy are targeted by GEF Operational Program 7, 'Reducing the Long-Term Costs of Low Greenhouse Gas-emitting Energy Technologies'. The following supply-side technologies are considered (but not limited to): grid-connected photovoltaics, advanced biomass (gasification and liquid fuels conversion), solar thermal electric technologies, large-scale wind power and fuel cells.

7.2 EU climate change-related support

The EU and its member countries support activities addressing climate change in developing countries not only through contributions to the GEF but also directly and through other multilateral channels.

7.2.1 European Commission

Support to environmental initiatives

The overarching objective of the European Commission (EC) in its support to developing countries is poverty eradication. This priority is reflected in the aim of the EC budget line B7-6200 'Environment in Developing Countries' to support innovative pilot activities and strategic studies that address negative environmental trends while contributing simultaneously to poverty eradication. By August 2000 a budget of 93 million ECU for a 7-year period (2000-2006) was pending of approval; 11,7 million were allocated for years 2000 and 2001 (European Commission, 2000a).

Priorities for co-operation are set year to year. One of the priority themes for years 2000-2001 is assisting developing countries in the implementation of their obligations within the UNFCCC. Specific priorities for funding are preparatory activities for the implementation of the Clean Development Mechanism (CDM)[12], energy efficiency and renewable energy.

Under the budget heading B7-8110 'Climate Change, Clean Development Mechanism' the EC is contributing to capacity building of institutions in non-Annex I countries. By May 2000 the available budget allocation was 150.000 ECU for up to three projects. Such projects should give incentives to the private sector in the host country to invest in CDM projects (research, education, communication and public awareness) and should assist the public administration to put in place the necessary structures for the identification, evaluation and selection of projects. Priority must be given to projects which favour the development of clean technologies (for example, renewable energies) and/or which involve NGOs in the process of selecting projects (European Commission, 2000b).

European Climate Change Programme

The EC has taken many climate-related initiatives since 1991, including the promotion of renewable electricity generation, voluntary commitments by equipment manufacturers and taxation of energy products. However, it is clear that action by member states and the EC needs enhancement if the EU is to meet its commitments under the Kyoto Protocol (reduction of greenhouse gas emissions 8% below 1990 levels by 2008-2012).

[12] Details on the CDM are provided in the next section.

The EU Council of environment ministers has asked the EC to develop proposals on priority actions and policy measures. In June 2000 the Commission launched the European Climate Change Programme (ECCP), with the goal of identifying and developing all the necessary elements of an EU strategy to implement the Protocol. The ECCP is preparing a range of additional EU-level policies and measures to cut greenhouse gas emissions as well as an EU emissions trading scheme (European Commission, 2000c).

Although the initial scope of the Programme is limited to the most promising emission reduction measures, in order to achieving the Kyoto target, in a mid- and long-term perspective the ECCP should incorporate issues such as adaptation, research, demonstration of efficient and clean technologies, training and education, and international co-operation, e.g. capacity-building and technology transfer in developing countries.

EU member countries
To what extent EU members states will be engaged in CDM depends on their national reduction targets in relation to the costs of greenhouse gas abatement in their own countries. Certainly not all countries will be actively looking for purchasing CDM credits. These countries also use multilateral institutions like the UNDP and World Bank[13] to promote capacity building and to purchase credits. EU member countries which do have already concrete initiatives on CDM are: Denmark, Finland, the Netherlands and Sweden.

7.3 Promoting renewables through the Clean Development Mechanism

The 1997 Third Conference of the Parties (COP-3) adopted the Kyoto Protocol under which Annex I parties will reduce their emissions by at least 5% compared to 1990 by the period 2008-2012. The Protocol defines as well the so called Kyoto (flexibility) mechanisms that allow Annex I parties to include into their emission reductions those made available by other parties. Such mechanisms are Joint Implementation (JI), Emissions Trading (ET) and the CDM. The first two are limited to Annex I parties, so only the CDM can be applied in developing countries (UNFCCC, 2000b).

Since not enough parties have ratified the Kyoto Protocol, it has not entered into force as yet. Before the 2000 Sixth Conference of the Parties this was expected to happen at the Rio +10 Conference in 2002 at the latest. However, the lack of agreements at the 2000 session in The Hague (to be resumed in July 2001) and the statements by the U.S. Government of March 2001 have tuned down the expectations.

The CDM is defined in Article 12 of the Kyoto Protocol as follows:
Its purpose 'shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.'

- Under the CDM, 'parties not included in Annex I will benefit from project activities resulting in certified emission reductions'. 'Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments'. 'Emission reductions resulting from each project activity shall be certified by operational entities' on the basis of: 'Voluntary participation approved by each Party involved'
- 'Real, measurable, and long-term benefits related to the mitigation of climate change; and'
- 'Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.'

[13] Most notably the Prototype Carbon Fund of the IFC will be actively looking for purchasing CDM credits.

In short, the CDM allows industrialised countries to purchase certified emissions reductions from projects in developing countries. Such projects should not only reduce greenhouse gas emissions that otherwise would occur (i.e. baseline scenario) but also contribute to the sustainable development of non-Annex I parties. Annex I parties can account the purchased reductions as part of their own emission reductions. Reductions can be accounted retrospectively from the beginning of year 2000 on despite the Kyoto Protocol not being ratified.

It is clear that the CDM requires further definition and much tighter specification before becoming operational. The next sections present the views of key African negotiators and researchers on the main issues regarding the CDM (Risoe, 1999). Given their specific needs and competitive situation in the world economy, African countries should pay particular attention to some additional issues:

- CDM projects should be undertaken within a national programme approach to ensure meaningful contribution to overall development objectives.
- Due attention should given to the selection of CDM projects. Choosing low cost options at an early stage, will make more difficult to later undertake options with higher cost or major development benefits
- CDM projects should involve significant and genuine technology transfer in order to enhance local capabilities.

7.3.1 Likely benefits and problems of the CDM

Provided an effective system for the operation of CDM is attained, this mechanism can prove beneficial to developing countries, especially to those like the African having a relatively greater need for development projects. The CDM is expected to:

- attract an increased flow of investments and capital intensive projects,
- incentive technology co-operation and partnership,
- stimulate market development and expand existing markets,
- improve the overall business environment,
- reduce the overall abatement cost by investing in countries with lower marginal costs,
- greatly enhance the negotiating capacity of Parties to the Convention,
- have positive impacts on the sustainable development of non-Annex I parties.

There are also problems that may emerge due to the introduction of the CDM:

- The level of contribution of CDM credits to the commitments of Annex I Parties will determine how well the global objective of UNFCCC is met.
- CDM would increase the administrative burden of Parties to the Convention.
- Countries with a weak private sector would find it difficult to effectively participate in CDM projects.
- Monitoring and verification of credits would become cumbersome, especially due to the varied nature of possible projects.

7.3.2 An Enabling Environment for the CDM

CDM projects should be compatible with national development and environmental priorities of the host countries. Therefore they need a well-articulated list of these priorities. Many developing countries like the African lack such information. In addition, host countries need to develop basic capacities and a well-organised business environment.

The following are the main elements needed:

- A very strong regulatory framework that is transparent, enforceable and clearly defined, including a complimentary arbitration system.
- An established business environment (including an effective banking system, insurance companies and stock market).
- An effective project information database for local and external investors.
- An organised and co-ordinated public institutional framework.
- An adequate and well maintained public infrastructure (energy, water and transport)
- A critical mass of experienced project developers, and business managers and strategists.
- A critical number of small and medium scale local firms capable of exploiting market niches and sub-contracting at acceptable standards.
- Strong and effective partnership links between government, private sector and NGOs.

7.3.3 Renewable energy and the CDM

Energy production and use is one of the main sectors responsible for the emission of greenhouse gases. On the other hand, the way energy resources are transformed and consumed has direct implications on the long-term sustainability of human development. This means that energy projects clearly qualify for CDM under the conditions set in Article 12 of the Kyoto Protocol, despite any further definitions and specifications for making the CDM effectively operational. In broad terms, energy projects that qualify for CDM may be classified into energy efficiency, energy substitution and renewable energies.

Specifically, renewable energy projects comply with CDM requirements when avoiding or reducing the use of fossil fuels (and thus emissions), either at the point of use or anywhere upstream in the energy chain, and at the same time contribute to sustainable development (e.g. by reducing local pollution and creating employment). One factor particularly in favour of renewable energy projects is that baselines are usually clear and emissions avoided easy to estimate.

7.3.4 Financing of renewables

Since certified emission reductions (CERs) would be traded in an international market, price paid for reduction of greenhouse gases at a given moment would in principle depend of supply (e.g. number and size of CDM projects operating) and demand (e.g. amount of CERs needed and proximity to the end of commitment period).

Different estimates on such price have been made for a variety of projects. It is very difficult to judge which of them is the best estimate, but the average is around US$8 per ton of CO_2-equivalent emission.

Just to show the possible effect of this price in grid-connected renewables in South Africa, the estimated contribution of CDM to a 300 kW windmill would amount US$0,01/kWh or Rands 0,07 per kWh, equivalent to 15% of the capital cost of the project (adapted from DANCED, 2001). Interestingly enough, this is twice as much as the current electricity generation cost claimed by ESKOM.

Two common expectations on CDM are that it may turn cost-effective otherwise unattractive projects, and that it would provide the full investment. However, this may not necessarily happen and the above example is useful to show this. Rather, CDM credits may enhance already cost-effective project and in a way ‘subsidise’ part of the capital or reduce operating cost.

On the other hand, the contribution of the CDM would not be completely free, in the sense that both national and international procedures, set respectively by the host country and the Convention, should be completed. If such procedures are excessively complicated and slow, project promoters may decide not to apply for CDM as resulting costs may offset the credits.

7.3.5 Special procedures for off-grid renewable energy projects

The current design of the modalities and guidelines of the CDM would involve high transactions costs per project, which would make it quite difficult for off-grid renewable energy projects to derive value from participating in the CDM. If not specifically addressed, the current CDM regulations would mostly favour large-scale urban and industrial projects and leave out opportunities for promoting clean rural development. This would be very unfortunate, since off-grid renewable energy projects rank high in terms of fostering sustainable development as well as offering a safe and long-term solution for climate change.

A current study undertaken by ECN, IT Power and Sunrise Technologies on streamlining processes for Solar Home Systems under the CDM indicates that even with competitive CER prices, the CDM could still make a valuable contribution to the dissemination of SHS (see Ybema et al., 2001). The same conclusion is also likely to apply to other off-grid renewable energy technologies.

Small-scale renewable energy systems can be excellent fit for the CDM's objectives, considering that they reduce greenhouse gas emissions while providing important development benefits for poor rural communities. The benefits of off-grid renewable energy include amongst others:

- Addressing the needs of a large percentage of the rural population, leading to:
  - improved living standards (especially for women and children) by increasing the quality of light and decreasing the fire hazard and toxic fumes from traditional lighting,
  - improved access to modern communication facilities,
  - increased rural economic development,
- Less local and indoor environmental pollution,
- Less reliance on foreign energy resources and thereby improving trade balance positions and reducing economic vulnerability to oil crises,
- Promoting the transformation to a sustainable energy provision by increasing the use of decentralised technologies using efficient appliances.

If off-grid projects are to be viable within the CDM, the transactions costs of their participation must not outweigh the value of CERs they generate. In order to keep transaction costs low, CDM eligibility rules should be fit for purpose and CER calculation procedures kept simple. This has been recognised by the UNFCCC Parties (UNFCCC, 2001):

> *'Standardised baselines (..) may be used for small-scale projects and renewable energy projects. The Executive Board is asked to elaborate on and make recommendations on preferential treatment of these specific project types'.*

Apart from the issue of standardised baselines, it is important to recognise that streamlined processes for off-grid renewable energy projects should not be limited to baseline development alone. Transaction costs are involved in every step of the CDM project cycle. Streamlined processes are required for monitoring plans, verification procedures, and credit purchasing schemes. Hence, the necessity for the Parties of the UNFCCC to make a special CDM window for off-grid renewable energy projects.

7.4 Climate Change framework in South Africa

Climate change issues are officially dealt with by the Department of Environmental Affairs and Tourism (DEAT). The National Climate Change Committee (NCCC) is mandated to advise DEAT in these matters. NCCC is formed by representatives of many sectors including government, large industries (ESKOM, Sasol, etc.), industry associations, universities, research institutions and NGOs, and chaired by DEAT.

Other governmental departments involved in climate change through NCCC are

- Department of Minerals and Energy (DME)
- Department of Trade and Industry (DTI)
- Department of Finance.

South Africa ratified the UNFCCC but not the Kyoto Protocol as yet. This is the very first step to be taken by the country to participate in upcoming CDM projects.

The government is committed to address climate change and was preparing a response strategy to be issued by the end of 2000 which involves minerals and energy, trade and industry, water affairs and forestry, transport, and agriculture. First indication of actions points to households, energy intensive industries and export sector.

In the international arena the government concerns are directed to reduce the potential impacts of climate change policies, to be implemented in Annex I parties, on South African exports of energy intensive products and coal to such countries.

On the export of energy intensive products, the strategy is to show commitment to reducing emissions, mainly from coal-fired power generation, in anticipation of any import barriers.

Regarding coal exports, based on Article 4.8 of the UNFCCC, South Africa demands that developed countries should not affect fossil fuel imports from developing countries. In the same context, South Africa calls for the diversification and expansion of economies of non-Annex I countries, highly dependant on fossil fuel exports, by the use among others of the financial and flexibility mechanisms under the UNFCCC and the Kyoto Protocol.

The use of the CDM as a vehicle to transfer technology is given special emphasis in the above statement. Analyses of technology needs are suggested, where national priorities and needs determine technology choices, and acceptability criteria select proven technologies for each application.

7.4.1 Importance given to the CDM

The CDM is present in the agenda of DEAT and NCCC but only a limited number of people fully understand the mechanism and its implications. CDM opportunities are only seen by large companies; e.g. ESKOM in the energy sector, NGOs and specialised research centres.

One of the few initiatives to enable South Africa for CDM was developed by the Energy and Development Research Centre (EDRC) at the University of Cape Town. The Project 'Capacity Building in CDM Project Activities: South Africa' was financed by the United Nations Environment Programme (UNDP) under its enabling activities on climate change. The purpose was to help local stakeholders prepare for the eventual introduction of the CDM in South Africa through providing background information on national priorities, identifying opportunities for CDM and developing case studies.

According to EDRC, CDM projects have the potential for generation of revenues for South Africa while supporting development. The CDM may contribute in increasing the presently limited human and technical resources, and at the same time alleviate impacts on local and environment. To take advantage of this potential, stakeholders must clearly understand the CDM process and create an enabling environment for attracting promoters.

7.4.2 Potential CDM project areas

The CDM capacity building project prepared a scan of the full range of potential CDM project areas, intended to convey a sense of their range and variety. Since CDM is open to innovative and entrepreneurial initiatives, successful projects may emerge from areas not considered in the scan. The areas identified are summarised below (Davis et al., 1999).

Sector	Potential CDM project area	Comment
Energy supply	Gas-fired generation stations	Likely future fuel source
	Clean-coal technology	Some potential reductions in emissions
	Large scale hydro-electricity	Requires regional trade
	Nuclear plant	Depends on pebble bed technology
	Cogeneration	1,200 MW potential estimated by ESKOM
	Renewable energy	Small contribution to total electricity supply
	Electricity from biomass	Dedicated plantations for power plants
	Closure of Sasol/Mossgas	Decision dominated by non-environmental factors
	Conversion of Sasol's feedstock to gas	Likely scenario
Manufacturing	Conversion to gas	Many potential opportunities
	Energy efficiency	Many potential opportunities
	Structural change	Unlikely to be CDM activity
Mining	Energy efficiency	Some opportunities
	Methane emissions from coal mines	Beginning to be investigated
	Control of coal dump fires	Already being dealt with
Agriculture & forestry	Afforestation	Not yet within CDM scope
	Improved management of natural woodlands	Potential opportunities in SA & region
	Control of fires	Difficult to measure impact
	Better use of forest & agricultural wastes	For steam & power production
Transport & communications	Improved public transport	Significant opportunities
	Urban planning	Difficult to measure impacts
	Improved vehicle efficiency	Problem dominated by old vehicle fleet
	'Telecommuting'	Difficult to measure impacts
Household	Efficient appliances in households	Lighting, refrigeration
	Solar water heating	Significant potential
	Fuel switching in households	Small contribution to overall energy use
	Energy efficient dwelling design	Significant potential
Government & commerce	Energy efficiency in buildings	Significant potential
	Energy efficient building design	Significant potential

The areas identified for renewables are further commented as follows:

- Wind farms

  There is increasing interest in the development of small-scale wind generating stations in the Western Cape. While these projects will be small compared with overall capacity, their viability may be improved significantly if included in a CDM initiative.

- Solar energy

  Small scale and stand-alone photovoltaic systems represent a cost-effective solution to remote area power supply. Again, this is unlikely to make a large impact on the overall supply of energy but represents a niche opportunity for CDM projects.

- Electricity from biomass
  Combustion of plant material grown expressly for electricity production.

Co-generation (of heat and power) as mentioned by EDRC may include the use of renewables. The most likely case in South Africa is increasing cogeneration in sugar mills and sawmills over their internal power demand, thus feeding the excess to the grid. In certain conditions, pulp and paper mills can also cogenerate and sell excess power.

One of the case studies developed within the CDM project refers to solar electrification in the concession area in the Northern Province, to be undertaken by the Rural Alternative Power Stores (RAPS) - NUON joint venture (the concession scheme is described elsewhere in this report).

The conclusion from the case study was that projects using SHS might not be the ideal for CDM from a purely emission reduction perspective, because of the high costs and relatively small emissions reductions. From a national perspective, the SHS system might be financially attractive if all the external costs of using the alternative fuels are captured in the analysis. However, cost effectiveness from the CDM investor's perspective depends on the specific financial arrangements between partners and agreements on credit sharing. Full details are provided in Davis et. al. (1999).

Section III

Recommended Actions to Stimulate the Market Penetration of Renewable Energy Technologies in South Africa.

8. ACTIONS FOR SOUTH AFRICAN - EUROPEAN CO-OPERATION ON RENEWABLE ENERGY

Although the deployment of renewable energy varies throughout the EU, the member states have in general an advanced renewable energy development programme compared to South Africa. This can be advantageous for South Africa in two ways:

- South Africa can benefit from the experience gained in the use of financial incentives and institutional arrangements for the promotion of renewable energy technologies,
- South Africa can benefit from the experience gained and the availability of mature renewable energy technologies together with a developed renewable energy industry including producers, developers and investors.

In this chapter, further actions are recommended to stimulate the market penetration of renewable energy technologies in South Africa. They are structured in actions to enhance the policy framework for renewable power generation (4.1), actions to enhance the policy framework for off-grid renewable energy (4.2) and recommendations to stimulate renewable energy project development (4.3). The text box below provides a summary of the actions.

Text Box - Summary of recommendations to stimulate the market penetration of renewable energy technologies

Actions to enhance the policy framework for renewable power generation

Action 1: Development of a 200 MW set-aside programme
Action 2: Develop and implement power purchase regulation
Action 3: Capacity building

Other policy related actions

- Disseminate successes and failures
- Integrated resource planning
- Tariff Structure
- Innovative financing
- Green power Marketing

Actions to enhance the policy framework for off-grid renewable energy

Action 1: Government stakeholders should convey the same message
Action 2: Raise awareness of end-users on electrification planning, the non-grid rural electrification programme, and renewable energy technologies
Action 3: Make electrification planning more transparent
Action 4: Integrate energy planning into Integrated Development Planning Process
Action 5: Capacity building to support the implementation of the non-grid electrification programme focusing on:
1) improved monitoring and evaluation capacity at DME, NER
2) technical and financial assistance for concessionaires

Other relevant actions:

- Conduct research on the optimal rural energy service structure
- Concessionaires should be responsible for all non-grid energy services in their concession area
- Special risk mitigation measures for economic activities
- Launch integrated PV follow up programme

Actions to promote demonstration and commercial projects

Action 1: Provide financial support
Action 2: Capacity building
Action 3: Provide technology

The recommended actions are based on the analysis done by the Synergy Project team, the results of which have been discussed at the workshop held with relevant stakeholders in February 2001 in Pretoria. In this workshop the recommendations were evaluated, elaborated, discussed and prioritised. Of course, the responsibility for the recommendations lies entirely with the project team.

8.1 Actions to enhance the policy framework for renewable power generation

In order to utilise the EU experiences, activities like knowledge transfer, studies and co-operative research should play an important role. This paragraph elaborates upon the potential role of the EU and EU countries in policy related activities.

It is important to note that since 1998 DME and an EU party, the Danish Co-operation for Environment and Development (DANCED), have taken steps to support bulk wind energy generation in South Africa, using the Darling Wind Farm as a pilot project. Studies for the development of the farm would be financed by DANCED and the United Nations Development Programme (UNDP), with some of the funds coming from the Global Environment Facility (GEF).

The first step was research on independent bulk power production with renewable energy sources. The initial outcomes were discussed with relevant stakeholders in September 2000. The resulting DME/DANCED study presents recommendations to DME and NER on the way forward. The actions presented below are in line with many of those recommendations

***Action 1**: Development of a set-aside programme*

The SA government commits itself to the development of a set-aside programme. The aim of this programme is to reserve a fraction of the total power demand (an initial block of 200 MW is being proposed) to the most competitive renewable energy producers. The distribution companies would be obliged to purchase the renewable power at premium prices.

Expertise would be required to assist DME and NER in designing the pilot phase of the set-aside and fitting it in the ESI and EDI restructuring processes. Interested developers and investors would also need assistance to participate in the selection process and then in the development of the IPPs.

Potential EU collaboration for the above may be requested from implementing bodies of countries already well experienced on set-aside programmes, notably the Department of Trade and Industry in the UK, responsible for the Non-fossil Fuel Obligation (NFFO). EU developers and investors participating in the national set-aside programmes could also be linked to their counterparts in South Africa in need of assistance, in order to develop collaboration and partnerships.

The majority of the Synergy workshop participants regarded the development of a set-aside programme as the most important action to be implemented on short term. Some additional remarks were made:

- the 200 MW set-aside should be seen as an initial target, not as a limit,
- legislation should be adapted in order to put the set-aside in place,
- clear and transparent rules must be developed and applied in order to enable a fair and proper competition,
- it should be clarified whether ESKOM should be able to participate in the competition; the general feeling was that this should be the case, but that ‘small’ producers should be protected against large ones.

For most stakeholders, it is unclear what they have to expect in the near future. In order to develop strategies and plans, it is essential for DME to develop and communicate a clear policy, including a time frame with deadlines, available budgets and responsible bodies. EU contributions in the policy field should be clearly focussed on assisting DME in realising this short-term target.

Action 2*: Develop and implement power purchase regulation*
Renewable IPPs and utilities have conflicting views on the value of the power to be transacted, so the purchase needs to be regulated by an independent body (e.g. NER). In the DME/DLANCED study an interim regulation is proposed from the beginning of the set-aside programme, to be later amended to encourage renewable IPPs beyond the set-aside.

Some expertise is needed to help the power purchase regulator in developing key issues (e.g. determination of avoided costs, compensation for externalities…). Bodies responsible for regulation and/or tariff setting in most EU countries (e.g. Germany, Denmark, Spain, just to mention some) have experience on these issues that may be relevant to South Africa.

The Synergy workshop participants regarded this action as highly important. The following items were addressed during the workshop:

- the roles and mandates of NER and DME should be updated. Their competence should be clearly defined to avoid mutual interference and conflicts,
- NER should revise the 5-year limitation to PPA currently in place,
- NER should conduct capacity planning aimed at ensuring continuity of electric supply.

Also for this action it is essential for DME and NER to develop and communicate on short term a clear policy, including a time frame for actions with deadlines and responsible bodies. Both DME and NER could benefit largely from specific assistance of relevant EU bodies.

Action 3*: Capacity building*
The pending restructuring process of the electricity sector will be very demanding for DME and NER, especially if the development of grid-connected renewables is to be integrated in the process. Both institutions feel that their capacity on renewables should be further developed.

It is important to note that DANCED is preparing a possible support to the DME on renewables and energy efficiency. A study tour to Denmark was arranged for August 2000 with participants from DME and NER, aimed at providing them with a direct insight of the Danish policies, strategies, regulation and institutional arrangements regarding renewables and energy efficiency.

Additional support on the implementation of grid-connected renewables may be obtained from other EU parties with relevant experience. For example, the current collaboration between DME, CSIR and the Netherlands (e.g. ECN) may be enhanced towards complementing the possible support by DANCED.

Bilateral programs between EU countries and South Africa have been shown to be effective and should be extended and further developed.

Other policy related actions

- *Disseminate successes and failures*

Europe has gained a lot of experience in matters of policy, regulation, market liberalisation, standards, project implementation, etc. Many South African stakeholders are interested to hear about the lessons learnt in Europe. This dissemination of success stories and failures should be organised in a structured way.

- *Integrated resource planning*

The WPEP requires the implementation of Integrated Resource Planning (IRP) in the ESI. IRP entails formulating plans to meet the country's future electricity needs at the lowest possible cost. Grid-connected renewables should be properly considered among the alternatives to conventional power supply, in order to ensure the gradual incorporation of the renewable potential in the energy system.

Expertise is required at DME and NER to include renewables in the modelling and forecasting procedures that will produce data for the IRP exercise. Some collaboration is already on the way between DME and the Netherlands Energy Foundation (ECN) regarding integrated energy planning at the sectoral level. This could be extended to cover the above mentioned needs of DME and NER, with the eventual participation of other relevant EU parties.

- *Tariff structure*

The WPEP states that tariffs for IPPs should consider full avoided costs; furthermore, it notes that environmental costs should be included in order to promote renewable generation. Along with power purchasing agreements, tariffs are the most important issue for making renewable IPPs viable beyond the set-asides.

Expertise is needed to design a tariff structure that promotes competition and efficiency, and at the same time considers the inherent disadvantages of renewables, especially environmental externalities. As mentioned earlier, bodies responsible for tariff setting in most EU countries have extensive expertise to share with South African counterparts.

- *Innovative financing*

Renewable IPPs face much more expensive finance as compared to conventional utilities. Expertise is required to assess the real risks of lending to renewable IPPs and to develop innovative finance packages addressing the particular characteristics of renewable grid generation, e.g. equity and debt capital, risk guarantee schemes, etc.

Most EU governments are familiar with specialised financing for renewables, notably in France, the UK, Spain, Germany and Italy. Implementation bodies in EU countries may be in position to collaborate with South African parties in the development of appropriate financial mechanisms.

- *Green power marketing*

Demand for green energy is slowly emerging in South Africa, initially from companies seeking to provide environmentally friendly products in foreign markets. Such demand should be linked to renewable IPPs as a way of covering their incremental costs.

Expertise is required to design the green energy option within the regulatory framework. Initially the regulator would approve the green tariff in a case per case basis. A market-based approach could be developed in a later stage, e.g. through green certificates.

Many EU member countries are involved in green investment funds, tariffs and/or certificates (Denmark, the Netherlands, Belgium, Germany, Italy, Finland, Sweden and the UK). Some of these experiences may be used to assist South African parties as required.

8.2 Actions to enhance the policy framework for off-grid renewable energy

In all the actions, mentioned below, the main actor to move is the Government of South Africa, and in most cases DME. The EU and European Governments could play a catalysing role by providing financial support and sharing their technical expertise for these actions. In Europe there is vast experience with the technical assistance and policy support for off-grid renewable energy projects gained through Official Development Aid and international climate change programmes. Apart from such knowledge transfer from Europe, direct exchanges with institutions from other developing countries responsible for rural electrification should also be stimulated.

Key actions:

Action 1: *Government stakeholders should convey the same message.*

One of the main problems perceived by the concessionaires is that DME and ESKOM (Distribution) provide different interpretations/messages on the concession programme. Action required is: DME, ESKOM-D, NER should convey the same message. Also participation of the concessionaires in the whole design process should be ensured by means of formal representation.

Action 2: *Raise awareness of end-users on electrification planning, the non-grid rural electrification programme, and renewable energy technologies*

PV suffers from a bad image in South Africa. This may distort consumer choices to participate in the Non Grid Electrification Programme and lead to misconceptions of what to expect from SHSs. This is due the lack of clarity in the government plans with regard to grid electrification and non-grid electrification and enforced by the 'Electricity for all' promise of ESKOM in the early nineties. Another reason for the bad image of SHSs is the bad experience with inferior PV products sold in the past by commercial 'fly-by-night' operators.

During the workshop participants argued that the effort required to address this lack of awareness is beyond the scope of the private sector participants but should be a task for the government. The objective of such an awareness programme is to enable end-users to make informed choices on the rural energy services options provided to them either via electrification, the Non-Grid Electrification Programme (NGEP) or commercial channels. Important components of such an awareness programme are:

- electrification planning for communities,
- explanation of the NGEP,
- explanation on SHSs and other relevant renewable energy technologies, the services it does and does not provide, different available technologies and important questions to ask..

Action 3: *Make electrification planning more transparent*

One of the most important issues, which has stalled the finalisation of the concession programme, is the lack of clarity on grid extension planning. Often grid extension plans are lacking, or promises have not been fulfilled. The lack of transparency of grid extension planning may have two causes. ESKOM may not be willing to disclose information because it may expose it to more political pressure. On the other hand, disclosing such information accurately over a long period of time is also quite difficult, especially given the scale and speed of ESKOM's operations. These two issues should be approached together. Special legislation may be adopted to tackle the first issue and capacity building to tackle the second.

Action 4: *Integrate energy planning into Integrated Development Planning process*

The major challenge when trying to integrate energy into other development activities is the level where the integration will take place. In the past many national and provincial government programmes have failed at the point of delivery due to lack of capacity or involvement of local governments. As a reaction, The Department of Provincial and Local Government has introduced the Integrated Development Planning (IDP), a tool for reorganising local government and setting strategic frameworks for project delivery.

The level where electrification plans can be integrated with other development initiatives has to match with the existing institutional structure of the South African government to promote rural development, which is the IDP process. The integration of energy into the IDP process has two major components:

- Energy planing into IDP - Considering that energy issues and income generation are high on the priority list of rural communities, it is quite relevant to develop local energy planning tools to assist districts in energy planning and decision-making. It will enable local communities to make informed choices of what is feasible and will help them express their needs towards ESKOM or the concessionaire in that area. Such a tool could be made available through the PIMS-Centre or other relevant local body.

- Making use of the implementation infrastructure of the concession programme- The concessionaires are established at the national level by DME, while the development planning through the IDP will take place at the district level. It seems therefore a priority to link the planners at the municipal level with the concessionaires. The concessionaire and the municipality could engage in the energy planning for each area and identify potential energy activities. Through such a process, concessionaires can be linked to income generation activities and assist in providing energy solutions to those initiatives.

In order to find out how energy actions can be integrated into the local IDP process, it was suggested at the workshop that a pilot project with a few interested municipalities could take place to identify the needs and key issues for such an action on the local level.

Action 5: *Capacity building to support the implementation of the Non-Grid Electrification Programme*
The Non-grid Electrification Programme is the single best opportunity for promoting the large-scale penetration of renewable energy technologies in South Africa. Because European parties are already deeply involved, stimulating this Programme is also a good opportunity to strengthen South African - European integration on renewable energy.

Given its experimental nature, there is likely be a lot of policy challenges for DME during the implementation phase of this programme. Policy flexibility on the side of DME is therefore an important component to meet its ambitious targets without jeopardising the needs of the end-users and the financial operations of the private companies. This flexibility should be enhanced within the involved implementation bodies, i.e. DME, NER and the concessionaires.

- *Improve monitoring and evaluation capacity at DME, NER*

The chances of addressing these policy challenges will be increased if proper monitoring and evaluation of the programme is conducted. It is therefore recommended that long term technical assistance to DME is provided during the implementation of the programme to strengthen the monitoring and evaluation capacity at DME and assist in finding creative solutions for the policy challenges. This technical assistance could also include a review of similar international initiatives in order to learn from other experiences with non-grid electrification in other countries.

- *Concessionaires*

The role of the concessionaires is in the first place is to operate a commercial rural energy service business in a commercial way within the margins of the NGEP. The low margins/high risk nature of their business combined with the constraints of commercial operations is likely to result in little space for the concessionaires to develop and test new practices to improve their services and try new technologies which in the long run would improve their energy services. In order to provide the flexibility within the NGEP to develop the most appropriate delivery mechanism, it is desirable to provide separate assistance to the concessionaires.

Assistance can be provided in two ways:
- Technical assistance to the concessionaires to expose them to other experiences with non-grid energy service delivery to poor rural households.
- Technical assistance to expose them to the latest technological developments on off-grid renewable energy, including new applications such as stand-alone small-scale wind turbines, small-scale biomass power generators and thermal energy providers

- Financial assistance to enable the concessionaires to experiment with new delivery mechanisms and technologies which in the long term can improve energy service delivery in rural areas.

Apart from improving the performance of the South African programme, the improved monitoring and evaluation of the programme will make it easier for other countries to draw valuable lessons learned from this programme.

Other relevant actions

- *Conduct research on optimising South Africa's rural energy services*

Currently, the delivery of rural energy services is distributed over different providers (ESKOM, municipalities and concessionaires), which provides unclear situation on responsibilities. At the same time, as part of the Electricity Sector Restructuring, the formation of 6 Regional Electricity Distribution Companies is being considered. Apart from these developments in the electricity sector, natural gas is being introduced. These developments raise a number of questions, which are relevant for long-term energy service strategy in rural areas in South Africa. Research in the provision of rural energy services models as well as analysing the compatibility of the current models to meet the long term energy needs of rural provisions would provide useful inputs into the long term rural energy policy decision making.

- *Concessionaires should be responsible for all non-grid energy services in their concession area*

By setting up the concession system, there is now an implementation capacity in place to deliver energy services in rural areas. The concessionaires will in the first instance be very much focused on delivering energy services to rural households, i.e. for consumptive applications. At the same time, there is a need for establishing energy services for rural industries as well. Since concessionaires have already the infrastructure in place, and the level of risk of such activities is too high to allow competition, they should also be mandated to provide other off-grid energy services in their area.

- *Special risk mitigation measures for economic activities*

The government should try to put in place separate measures to facilitate the investments in renewable energy projects to economic activities in rural areas, likewise they had done it for households. During the workshop, a number of barriers were identified hindering the deployment of renewable energy for economic activities:

- lack of training & awareness,
- lack of funding,
- sectoral instead of holistic approach blocking development initiatives,
- high-risk,
- no IPP-framework,
- confusion on ESKOM task division.

One of the main barriers to economic activities is the lack of rural economic activities. This could be advantaged by integrating energy into the IDP process (see point above) with a special emphasis on involving local communities.

It was concluded that the concessionaires should be the main responsible for providing energy services to economic activities in rural areas (see also previous point). They would have access to finance to develop decentralised energy projects and could in turn sell the power to the project developer under a power purchase agreement. However, concessionaires would only get engaged if such ventures are commercially viable for them. Energy projects for economic activities require higher investments than household and hence are surrounded with more risk. They involve small-scale activities from companies which often have no financial track record and which face uncertain market prospects. Special support measures, similar to the ones provided to rural households, are therefore also required for off-grid renewable energy projects for economic activities. Such measures could include:

- subsidy on capital expenditures (similar to the one provided for households) to create a level playing field with grid extension,
- guarantee fund for the power purchase agreement,
- assistance to project developers: economic, financial, legal skills to set up commercial projects,
- integrate this into the IDP process (see point above),
- make concessionaires responsible for such activities (see point above).

- *Launch integrated PV follow up programme*

As part of the programme to improve the public image of PV, DME may wish to consider developing policies targeted at improving operation and maintenance of installed PV systems in the field. This operation and maintenance campaign could be targeted at all pilot and public PV projects which overlooked a clear operation and maintenance back up strategy in the project implementation, for example, the clinics and schools programmes, and the farmer project in the Transvaal. The idea is that before starting new PV project, the mess of old ones has to be cleaned up.

Such a programme could at the same time be combined with training local technicians, and raising awareness on the potential of PV among end-users, and train them on how to properly use and maintain PV systems. It could also be linked to the PV infrastructure that will be put up by the concessionaires. Stakeholders to be involved in this programme are the concessionaires, PV suppliers, ESKOM, Department of Trade & Industry (DTI), DME, Department of Housing (DoH).

8.3 Actions to promote demonstration and commercial projects

Different demonstration projects have been implemented or are in development. These include projects in the field of wind, biomass, solar thermal power and wave energy. Also grid-connected PV and low cost energy efficient housing are being considered. Being not commercial viable, these demonstration projects need financial support. This support could be given by the government or international co-operation. At present, several demonstration projects are already in further stages of development. In the development of a set-aside programme, special attention should be given to those projects. Opening a tendering procedure under the set-aside programme could easily kill these projects, although probably a lot of efforts have been invested already. One option would be to allow for demonstration elements within the set-aside programme.

The following actions can be distinguished:

Action 1*: Providing financial support*

- *Financing for renewable energy projects*

Financing for renewable energy projects is currently provided via export subsidies and ad hoc funding by the overseas development assistance (ODA). Export subsidies are not considered the appropriate route to stimulate financing of renewable energy technologies in South Africa. They do not favour optimal technology assessments, create unfair competition between companies from different EU member states and have a negative impact on developing a local manufacturing capacity in South Africa.

The other route, via ODA, is characterised by its ad hoc nature. Donors often shift priorities and co-ordination among them is lacking. There could be case for providing such funding on a more systematic basis by linking EU parties willing to invest in green energy abroad with project opportunities in South Africa. This may be formalised through the set-up of a renewable energy fund.

Although many foreign countries are hesitating to provide financial support on project level, South African stakeholders clearly expressed the view that providing financial support is essential for implementing the majority of renewable energy projects. Apart from existing export subsidies and the CDM, European governmental bodies should seriously look into the possibility of setting-up a renewable energy fund. This does not necessarily have to be restricted to South Africa, but could apply to the whole SADC-region.

- *Clean Development Mechanism of the UNFCCC*[14]

Upon entry into force and ratification of the Kyoto Protocol, the possibility will exist to sell CO_2 reduction credits from South Africa through the CDM. Considering its excellent fit with the objectives of this mechanism, renewable energy should play an important role in the CDM activities of both EU and South Africa. Special concern in this regard is required for off-grid renewable energy projects.

For off-grid renewable energy projects to be viable within the CDM, the transactions costs of their participation must not outweigh the value of Certified Emission Reductions (CERs) they generate. In order to keep transaction costs low, CDM eligibility rules should be fit for purpose and CER calculation procedures kept simple. This would be stimulated if the EU, EU member States and the Government of South Africa would adopt a special CDM window for off-grid renewable energy systems under the CDM.

Action 2*: Capacity building*

In order to institutionalise capacity building it is recommended to start a mutual South African - EU programme that could serve as a focal point and match-making platform for different kind of stakeholders. This focal point could also serve to inform about, and eventually to co-ordinate activities in South Africa conducted bilaterally by different EU countries.

Another part of this action could be to organise an educational programme comprising for example student exchange, centres of excellence and chairs for renewable energy.

The capacity building programme could include the following areas:

- *Building-up technological expertise*

The European Union is actively promoting the implementation of renewable energy. This resulted during the past years in many projects being developed and implemented throughout the Union. Parties involved in these projects have gained expertise and know-how that could be valuable in South Africa. Specific items, where one could think about are:

- integrating renewable technologies in the grid,
- technical design aspects of mini-grids,
- wind measurements,
- local manufacturing of components.

- *Building-up expertise on project development and implementation*

Due to the large amount of renewable energy projects being developed and implemented in Europe, there is large experience with conducting extensive feasibility studies, preparing bankable business plans, and implementing projects. This experience could be of valuable means for South African parties.

[14] United Nations Framework Convention on Climate Change

- *Building-up expertise on dissemination of knowledge and information*

In order to promote renewable energy technologies in specific countries or regions, demonstration projects have been implemented with a focus on gaining and disseminating knowledge and information. Apart from specific target groups, these demonstration projects were also used in order to get a broader public acquainted with specific technologies.

Action 3*: Providing technology*

Europe has well-established renewable energy production facilities. In the field of wind energy, Europe can be regarded as the world market leader. Also biomass technologies are being manufactured in Europe at a large scale. Wave energy and solar thermal energy technologies are less mature, but there are a number of European manufacturers involved in developments in this field.

This means that Europe can provide technological hardware for projects in South Africa. These technologies have been exported already world-wide for years and have proved to be suitable for different climatological conditions. These conditions however change from region to region. Therefore it is recommended to develop joint research and development programmes, aimed basically at adapting EU technologies to (South) African conditions and to analyse possibilities for manufacturing in South Africa.

8.4 Other actions for South African - European co-operation

Some elements of an EU - South African action plan for grid-connected renewables were suggested by the participants. EU parties should see this collaboration as a starting point to access the SADC market.

- disseminate successes and failures within the EU in matters of policy, regulation, market liberalisation, standards, project implementation, etc.,
- link EU parties willing to invest in green energy abroad with project opportunities in South Africa. This may be formalised through the set-up of a renewable energy fund,
- organise an educational programme comprising for example student exchange, centres of excellence and chairs for renewable energy (I would suggest a small survey on existing initiatives to find out whether we should build on them or start something new),
- develop joint research and development programmes, aimed basically at adapting EU technologies to (South) African conditions,
- analyse possibilities for manufacturing in South Africa,
- research successes and failures of renewables in South Africa by EU parties.

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