Energy Division
Office of The President
State House

Permanent Interstate
Committee for Drought
Control in The Sahel (CILSS)

HOUSEHOLD ENERGY STRATEGY FOR THE GAMBIA (HES)

Compiled by:

Development Management Consultants International (DMCI)

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LIST OF ABBREVIATIONS AND ACRONYMS

LPG – Liquefied Petroleum Product
EDF – European Development Fund
PV – Photo Voltiac
HFO – Heavy Fuel Oil
NAWEC – National Water and Electricity Company
ADB – African Development Bank
TOE – Tonnes Oil Equivalent
OP – Office of The President
DOSFNRE – Department of State for Fisheries, Natural Resources and Environment
DOSFEA – Department of State for Finance and Economic Affairs
DOSLG&L – Department of State for Local Government and Lands
NEA – National Environment Agency
GNPC – Gambian National Petroleum Company
POPs – Persistent Organic Pollutants
DMCI – Development Management Consultants International
GDP – Gross Domestic Product
OMVG – Organization for the Development of The Gambia River Basin
GREC – Gambia Renewable Energy Centre
GFMC – Gambia Forest Management Concept
NARI – National Agricultural Research Institute
SOS – Secretary of State
FD – Forestry Department
CFM – Community Forest Management
CCSF – Community Controlled State Forest Management
JFPM – Joint Forest Park Management
VDC – Village Development Committee
GGC – Gambian Groundnut Corporation
FACS – Federation of Agricultural Cooperative Societies
DCD/ATU – Department of Community Development/ Appropriate Technology Unit
GTTI – Gambia Technical Training Institute

SUMMARY

Background

The Gambia drives its energy from four sources. These are fuelwood, petroleum products, electricity and renewable energy: two indigenous and two modern or non- indigenous. The fuelwood resources comprise firewood and wood charcoal. Although wood charcoal production was banned in 1980 by a Presidential Degree, its consumption continued to be nurtured through imports and clandestine local production. The petroleum products resources comprise petrol, diesel oil, heavy fuel oil (HFO), liquefied petroleum gas (LPG) and kerosene. Electricity source remains NAWEC using thermal generation. The renewable energy sources comprise solar, wind and biomass.

According to the average energy consumption (1990 – 2004), fuelwood accounts for more than 80% of total energy consumed. Petroleum products that comprise petrol, diesel, heavy fuel oil (HFO), liquefied petroleum gas (LPG) and kerosene is the second most important source accounting for about 17%. Electricity consumption accounts for less than 3% and renewable energy (comprising solar, wind and biomass) account for less than 0.1%. The total national energy consumption in 2004 is estimated at 467 Thousand Tones of Oil Equivalent (TOE). Of this total national energy consumption, fuelwood accounted for 374.89 Thousand TOE, representing 80.1%. Fuelwood consumption is further segregated into urban 37% and rural 63%. The shares of the other energy types were estimated as 83.3 Thousand TOE representing 18.1% for petroleum products, 7.17 Thousand TOE representing 1.5% for electricity and 0.23 Thousand TOE representing 0.05% for renewable energy mainly solar photovoltaic.

The relative shares of the total household energy consumption/demand for the four energy types are fuelwood 97% (95% firewood and 2% charcoal), petroleum products 1.60% (1.09% kerosene and 0.51% LPG), electricity 0.9% and renewable biomass 0.4%.

The analyses of demand and supply growths of household energy in The Gambia established that the situation can best be described as gloomy and that albeit surmountable, the constraints are formidable. The key factors of demand growth are population growth, inter-fuel substitution and performance of appliances and method used. Supply growth is influenced by institutional and regulatory aspects of the industry, effectiveness of the forestry control mechanism and the extent of community involvement in the management of energy resources.

Of the four energy sources, fuelwood accounts for more than 80% of the total national energy consumption and about 97% of the household energy use. All the non-indigenous sources are imported and exert great pressure on the country's foreign trade balances.

Energy Resources

The fuelwood resource base is the national forest cover constituting about 43% of the total land area. The country's forest cover has been under severe pressure from the burgeoning population and its associated anthropogenic activities since the 1960s, including firewood collection and charcoal making, the two forms of fuelwood.

Electricity is produced by thermal generation using either diesel or HFO fired generators. Commercial electricity generation is exclusively done by the National Water and Electricity Company (NAWEC) with a current installed capacity of about 46 MW producing about 163,062 MWh in 2004.

Renewable energy sources include wind, solar and biomass (other than fuelwood) together, accounting for about 0.41% of total household energy consumption. Of the three renewable energy sources, biomass has the greatest potential followed by solar with wind trailing as the least potential of household energy source.

Background To The PREDAS Studies

Amidst the growing concern for sustainable supply of energy services for the household sector in a sustained and environmentally sound manner, PREDAS (Regional Programme for the Promotion of Domestic and Alternative Energies in the Sahel) in collaboration with the Energy Division of The Office of the President commissioned a series of four sectoral studies under the supervision of a Technical Working Group of The Gambia chaired by the Director of Energy during the second half of 2004 culminating in the elaboration of the Elements of Household Energy Strategy (HES) in The Gambia. The sectoral studies included:

i. National household energy consumption survey, to describe the types and quantities of energy used as well as perception toward the different forms of energy;
ii. Charcoal sector review to describe the current process of charcoal production and supply as well as identify barriers to improving the efficiency;
iii. Charcoal briquetting study to identify the feasibility and the potential of supply of charcoal briquettes made from carbonized agro-industrial residues, to replace wood charcoal; and,
iv. Review of the experience with community-based natural resource management.

Outcome Of The Sectoral Studies

The national household energy consumption survey provided, in addition to the information requirements of its terms of reference, insightful knowledge of the socio-economic profile of sample households of relevance to a well conceived household energy strategy. These socio-economic issues relate to the perception of general developmental problems, social and demographic characteristics of households and other household information of relevance to energy consumption and demand. The analyses of the study findings on the household energy-specific issues are summarized hereunder by the four broad energy classification in The Gambia :

- **Fuelwood Energy Sources:** Fuelwood is the most important household energy source, the three-stone is the most important appliance in use, the majority of communities have no rules regarding firewood collection, over 45% of rural households produce their own charcoal, use of improved charcoal stoves is still limited, and the majority of households are not aware of the ban on charcoal production;

- **Petroleum Product Energy Sources:** Majority of urban households use LPG and non-users advanced high cost for non-adoption, kerosene is mainly used by rural households, hurricane lamp is the most important appliance and kerosene is cheap but smelly;
- **Electricity Energy Sources:** NAWEC is the most important source of electricity, its availability is erratic and unpredictable and average supply availability is 5 hours in the urban area and 4 hours in the rural areas; and,

- **Renewable Energy Sources:** Use of solar PV system is low and so is awareness of solar cooker stoves, combustible biomass resources are used in both urban and rural areas with saw dust being the most widely used and the popular opinion about biomass is that it is cheap and easily available but dirty and smelly.

The wood charcoal sector review established that about 15,000 metric tones of charcoal are consumed in The Gambia annually of which 13,000 tones are consumed by urban households. There are three major sources of charcoal. These are illegal commercial producers, subsistence producers and imports. Over 72% of the illegal commercial producers are in Western Division. The total recorded imports in 2004 amounted to about 2,000 tones. The largest numbers of subsistence producers are in CRD and NBD, together accounting for 57.5%. The charcoaling technique in use is the traditional earth kiln which is inefficient and destructive. Although charcoal making is an important source of employment and income for women, it also accentuates forest degradation through deforestation and depletion of green manure and causes pollution through the release of carbon monoxide into the atmosphere.

The biomass charcoal briquetting study established that it is economically, socially and environmentally feasible to produce charcoal briquettes from agricultural and agro-industrial residues. There is a good potential of producing about 45,000 to 57,000 tones of biomass charcoal briquettes annually. The processing options are centralized and decentralized processing locations and a combination of the two. The manufacturing option is a briquetting plant incorporating carbonization equipment. The briquetting plant can be located at Denton Bridge and the carbonization equipment be located at villages so that the carbonized material can be transported to Denton Bridge and final briquette product can be marketed to rural sales out-lets through the existing groundnut transiting channel. Possible enterprise choices are a limited type enterprise such as GGC, producer organization type such as FACS and joint stock enterprise such as GGC and FACS. The joint enterprise option is recommended. The Cooperative Primary Marketing Societies (CPMSs) can own the carbonizing equipment as shareholders in the venture. The prelimary financial analysis established that the cost of biomass charcoal briquette is about D0.83/kg or D0.18kg/Mcal compared to the current cost of charcoal of about D3.04/kg or D0.43/Mcal. Some legal, fiscal and regulatory incentives necessary would include banning the production of charcoal and increasing licensing fees for importation; allowing for 100% depreciation of the plant; duty and sales tax exemption; and, involving the Department of Forestry, Customs and Excise and Immigration in the enforcement of the legislation banning the production and regulating the imports of wood charcoal.

The review of the experience with community-based natural resource management establishment that a number of participatory forest management models were developed and tested since 1990 through mainly German Technical Assistance. This heuristic process led to the adoption of a generic participatory forest management approach commonly referred to as

The Gambia Forest Management Concept (GFMC) in 1995. Further development of the concept yielded three variances: Community Forestry, Joint Forest Park Management and Community Controlled State Forest. Parallel institutional, legal and organizational reforms to the development of the concept included the adoption of a new forest policy in 1995, enactment of new forest legislation in 1998, the enactment of the Local Government Bill 2000 and restructuring of the forestry field administration in 2002. Although the effectiveness of these reforms in terms of forest control is yet to be fully realized, they provide a framework for a sustainable village-based participatory management of forest resources within the context of a resilient household energy strategy in The Gambia.

Relative Importance of the Different Energy Sources

There is a distinct rural/urban divide in the use of the four energy sources by household. The rural households consume more firewood and kerosene than the urban households, the urban households consume more charcoal, LPG, electricity and biomass than the rural households, and approximately the same quantities of LPG and biomass are consumed nationally.

In terms of relative cost per unit of TOE equivalent, firewood is the cheapest with D605.46, followed by charcoal with D8,371.60, followed by biomass and kerosene tying with D10,738.85, followed by LPG with D32,407.45, and electricity is the most expensive with a unit TOE cost of D52,790.67.

Institutional Set-up

- Existing policy planning and making, technical development and operational management of the energy resources cut across a number of public, private and civil society agencies and organizations.

- The key policy level structures are the Office of the President, and the Department of State for Fisheries, Natural Resources and the Environment, Finance and Economic Affairs and Local Government and Lands.

Principles of the National Energy Policy

- The quintessence of the National Energy Policy is one of recognition of energy as the engine of socio-economic growth and development and, that fuelwood is the most important energy source of the country with serious limitation as to applicability and supply.

- Thus the key public sector developmental function is instituting a monitoring/early warning mechanism that provides regular information flow for timely responses.

Demand for Household Energy

- The demand for household energy is influenced by a host of macro-/ and micro-level factors.

- At the macro-level, the key determinants of aggregate demand for household energy are population and socio-economic factors.

- At the micro-level, the key determinants of the relative demand for the various household energy type appear to be use, attributes and cost.

Supply of Household Energy

- Albeit differently, the supply of the two broad groups of indigenous and modern forms of household energy types are influenced by the same set of factors.

- The key factors that have shaped and continue to drive fuelwood supply are the forest cover, population and public forest policy including institutional, legal and regulatory frameworks of forest management

- Overall the prospects of sustainable fuelwood supply from the country's forest resource are very bleak.

- The key factor influencing the supply of petroleum products and electricity are the legal and institutional frameworks and their huge demand for foreign exchange resources.

- The institutional constraints on renewable energy sources are less stringent although the lead technical agency is exceptionally weak.

- There are no specific legal provisions on renewable energy production however the existence of such a provision will be critical for the successful production and promotion of biomass briquettes as a substitute for wood charcoal.

Ongoing Activities in the Household Energy Sector

- Households are the dominant consumers of the national energy production and therefore any initiatives in the energy sector are of relevance to a household energy strategy in The Gambia.

- The major activities in the energy sector are mainly infrastructural, legal, socio-economic research and policy development initiatives.

- These activities will have significant favorable demand-side and supply-side effects

Perspectives and Main Constraints.

- The outlook of the household energy situation can best be described as gloomy and the constraints formidable albeit surmountable.
- The constraints impact on demand and supply growths differently, resulting in different outlook scenarios.

Demand Growth

- Demand growth of the energy sector generally and the household energy component in particular appears to have been and will continue to be shaped by three major processes: population growth, inter-fuel substitution and, the performance of appliances and method used.

- Population growth and its anthropogenic ramifications impact on demand growth of household energy positively with equal ferocity of backwashing effect on supply especially fuelwood demand and supply.

- Inter-fuel substitution, represented by the relative growth in the shares of the various energy components of the household energy balance, predicts a welcome aggregate demand growth pattern with LPG and biomass increasing at the rate of about 61% and 716% per annum.

- Despite the impressive array of improved household energy efficient appliances, the traditional three-stone remains the dominant appliance for all cooking for about 60%.

- The greatest constraint to expand demand growth appears to be lack of effective awareness creation as an ongoing process.

Supply Growth

- Supply growth of the energy sector generally and household energy component in particular appear to have been and will continue to be influenced by three major factors: institutional and regulatory aspects of the industry, effectiveness of the forestry control mechanism and the extent of community involvement in the management of energy resources.

- The key institutional and regulatory aspects influencing supply growth of fuelwood are technical capacity and organizational structure of the Forestry Department and, the legal and fiscal regulatory requirements of the fuelwood industry.

- The major factors which have shaped the growth of supply of petroleum and products are low level of regulatory arrangements, un-remunerative revenue allocation formula, low structural development and weak coordination of the industry policies and strategies.

- The fuelwood supply/demand balance as at 2004 is a whopping deficit of about 685,940 tonnes representing about 69% of the national fuelwood consumption which falls within the anecdotal estimated range of 60-80% of fuelwood imports.

- The fuelwood market is a vibrant economic activity employing a wide spectrum of actors including producers, wholesalers and retailers with the largest share of the income accruing to the wholesalers.

- The fiscal structure of the industry and its influence on the price constitute the key regulatory mechanism of the fuelwood market.

- The non-indigenous petroleum product source includes kerosene, liquefied petroleum gas (LPG), petrol, diesel oil and heavy fuel oil (HFO).

- Kerosene and LPG are the main petroleum products used for direct household energy production and together, accounting for about 1.47% of the total household energy consumption.

- While the kerosene market is driven by oil companies, the LPG market is dominated by small private companies.

- Electricity comes from the three main generating sources (NAWEC, private generators and solar PV systems) and accounts for about 0.8% of the total household energy consumption.

- The small private generators and solar PV systems (renewable energy) have an installed capacity of about 640MWh.

- The solar energy market is dominated by small energy device companies.

- The major constraint to the growth of supply of electricity in addition to the influence of the constraints in petroleum supply is under-capitalization of the industry.

- The major constraints to the growth of supply of renewable energy are lack of effective regulatory and coordination framework, low level of infrastructural and technology development and, low level of research, development and promotion activities.

- The Gambia Forest Management Concept (GFMC) and the new Forest Policy were specifically designed to increase the effectiveness of forestry control through the devolution of the management of forest matters to the local level.

- Although these initiatives have resulted in significant increase in annual log supply of $1500m^3$ and $2,200m^3$ from natural forests and plantations respectively, the weight of evidence in terms of total forest area brought under controlled management (12%) appears to negate the effectiveness of the forestry control mechanism.

- The Local Government Act, 2002 provides for the management of natural resources to be assumed by the councils and correspondingly provides for councils to establish Departments for the administration of the forest and the setting up of Local Natural Resources Committees.

- These institutional structures which may have far reaching effect on supply growth of fuelwood are yet to be established.

Base Line Scenario for the Development of Demand and Supply

- The base line scenario for the development of energy demand and supply is a whopping supply deficit of about 348,040 TOE representing about 53% of total nation consumption as at 2004

- The individual energy type base line scenarios are:

- Fuelwood a deficit of 346,290 TOE representing about 68% of national fuelwood consumption;

- Petroleum and Petroleum products balance is a negligible deficit of about 500 TOE representing about 0.6% of consumption;

- Electricity is a positive supply balance of about 4,380 TOE representing about 45% of total consumption; and,

- Renewable energy is a positive balance of about 42,440 TOE representing about 1,878% of consumption.

- This state of affairs of the energy demand/supply balance alludes to a serious rate of erosion of the forest capital.

A HOUSEHOLD ENERGY STRATEGY FOR THE GAMBIA

Based on the foregoing background findings of the various sectoral studies and an analysis of the energy demand and supply situation of the country, a Household Energy Strategy for The Gambia, was finalized as adopted by the National Validation Workshop of 12/13 April 2005. Consistent with a National Energy Policy which recognizes energy as the engine of socio-economic growth and development and that fuelwood is the most important energy source of the country with serious limitation as to its applicability and supply, the articulated cardinal issues of the strategy are summarized hereunder:

Specific Objectives: The medium-term objectives are to stem the on-going degradation of the forest resources; promote the development of alternative and renewable energy resources; improve the adequacy, efficiency, reliability and security of electricity services; expand adoption of petroleum products; and, strengthen the institutional capacities of the industry.

Expected Results: The expected results of the strategy are a vibrant household energy sector; strengthened research, development, dissemination and regulatory capacities of the sector; and, production and adoption of non-traditional forms of household energy.

Principles and Strategy Orientation: The principles and strategic orientations of the strategy are a broad-based population involvement in the effective management of household energy resources; holistic approach based on comparative advantage of various energy types; adaptive research which emphasizes demand reduction measures within a conducive political and economic environment. The strategy focus of immediate-term actions are on forest protection and conservation; promotion of renewable energy sources; strengthening research, development, extension and regulatory capacities; rural electrification; and, improving the poverty/energy/environmental nexus within a sub-regional context.

Institutional Set-up: The institutional actions of the strategy will focus on strengthening the existing institutional framework for the development and management of energy resources through rationalization and reform including the creation of the Department of State for energy; privatization of NAWEC; establishment of a National Energy Commission; establishment of biomass charcoal briquetting enterprise; and, establishment of a financial instrument in the form of a Fund.

Regulatory Improvements: The regulatory improvements will focus on such remedial institutional and legal measures including the enactment of new laws; introduction of safety and quality standards in the energy industry; and, increased national scientific and research capabilities.

Fiscal Interventions: Given the deepening widespread poverty, the dominance of fuelwood energy source is not likely to be abated without calculated fiscal measures aimed at altering the existing relative price structure of traditional energy that would make alternative domestic energy services competitive with fuelwood and charcoal.

Efficient Energy Management: Promote the use of efficient energy devices for the household energy sector as a measure to maximize the utilization of the scarce energy resources;

Information, Education and Communication: Provide adequate information to the population on the various aspects to household energy services such as efficient utilization of scarce resources, new and efficient cook stove, alternative and renewable energy (biofuel) stoves and fuels.

Technical and Financial Assistance to Private Operators: Technical and financial assistance to private operators will be critical to expand supply and adopt renewable energy resources and technologies;

Research: Gambia Renewable Energy Centre (GREC) based at Kanifing, as the technical arm of the Energy Department, should be strengthened to undertake scientific research capabilities particularly on adaptive research into alternative, renewable and new domestic appliances and also serve as the pivot for information, education and communication;

Training: Mitigating the capacity constraints in the energy sector will be crucial for the successful implementation of this strategy**.** Such capacity building initiatives will concentrate on building individual research and development capacities; building individual professional and technical commercial skills; local production of fuelwood end-use appliances; and, creation of private sector-led local production and maintenance of alternative and renewable energy fuels and devices.

Monitoring and Evaluation: The Energy Department should be strengthened to assume the monitoring and evaluation of all household energy service provisions and the Forestry Department strengthened as well to continue its responsible for monitoring and evaluating the management of the forest resources for sustainable supply of fuelwood.

1. BACKGROUND

1.1 Energy Sector Situation

The Gambia derives its energy from four sources: fuelwood, petroleum products, electricity and renewable energy. Fuelwood is the main energy resource of the country and contributes more than 80% of the country's energy requirement. The Gambia's forest cover, the source of its fuelwood, is subjected to a number of pressures. The overall forest cover diminished from 81.2% of the land area in 1946 to 41.5% in 1998. Apart from renewable energy, which is developing, the rest are non- indigenous.

The non-indigenous resources are imported and exert great pressure on the country's foreign trade balances. This state of affairs does not only make The Gambia's energy situation precarious but also places its socio-economic development in a dilemma given that cheap energy is essential for the competitive development of the productive sector of the economy.

Without cheap energy for production, the export base will not be able to expand to earn foreign exchange for the country. Cost of energy in The Gambia is said to be one of the highest in Africa, which erodes one of the country's principal conditions of competitiveness.

1.1.1 Energy Resources

The Gambia's household energy resources are fuelwood comprising firewood and wood charcoal; electricity derived from thermal generation; and, renewable energy resources comprising wind, solar and biomass. The following summarises the current state of these household energy resources:

Fuelwood Resources:

The fuelwood resource- base is the forest cover of the country constituting about 43% of the total land area of the country. It comprises the closed woodland, open woodland and savannah woodland. **Table 1.1** presents the pattern of degradation of the forest cover in terms of percentage changes in forest type. The fuelwood resources are firewood and its charcoal derivate.

Fuelwood contributes about 97% of the country's total household energy needs, constituting about 98% of rural household consumption and about 95.5% of urban household consumption. These statistics eloquently express the all importance of fuelwood in The Gambia's household energy basket. The resource-base of the energy, the country's forest cover, has been under severe pressure since the 1960s. The forest cover declined from 81.2% of the total land area in 1946 to just about 40.7% in 1993. The reduction in the closed forest type has been most dramatic, plummeting from 60.1% in 1946 to 0.7% in 1993. In effect, closed forest has almost disappeared from The Gambia's vegetation map within a period of 50 years. During this same period the country's population density grew from 35/km^2 to 108/km^2.

Table: 1.1 Percentage Changes in the forest cover by Forest type since 1946 Projected to 2015

Forest Type	1946	1968	1980	1993	1998	2005	2015
Closed Woodland	60.1	8.0	1.3	1.1	0.7	1.5	2.8
Open Woodland	13.3	14.6	10.7	7.8	6.2	12.0	12.2
Savannah	7.8	31.6	24.8	31.8	34.6	31.5	25.0
Total Forest Cover	81.2	57.3	36.8	40.7	41.5	45.0	40.0

Source: NAD, Action Plan on Forest and Wildlife Management (1999)

Population pressure and its attendant consequences on the natural resource base have contributed to the rapid depletion of the forest cover. Agricultural expansion, clearing land for human settlement, over harvesting of the forest products, overgrazing, and lack of proper management of forest resources have been the major causes of this phenomenon.

Electricity Energy

Electricity is produced mainly by thermal generation and to a lesser degree by the application of solar photo voltaic systems. NAWEC, the national electricity company, is the sole producer of commercial electricity. It operates a central power station located at Kotu. It also runs smaller generation units at the provincial administrative centres and in other locations. The generators at Kotu Power Station are fired by HFO whereas the other generators are fired by diesel fuel.

Commercial electricity production is marked by a number of problems. These include under-capitalisation, a rigid tariff system, escalating fuel prices, transmission and distribution losses and non-settlement of huge arrears especially by institutional consumers. Consequently, the company has great difficulties in meeting its operational costs, replace obsolete equipment and to invest in generation capacity expansion.

Table 1.2 shows the growth trends in population and imports of petroleum products while **Table 1.3** shows the situation in generation capacity and power production. The major investments that occurred in capacity expansion were in 1997 and 2001. It may be noted that a number of generators have in reality ceased to operate or are simply obsolete. Consequently, the investments have translated in almost intangible effective production. Households have not noticed any change for the better. The situation leaves the growing population unable to access electricity.

Table 1.2: Evolution of Quantities of Fuel used for Power Generation

Year	Population (million)	Petrol '000 metric tons)	Diesel (Total)	Diesel (NAWEC)	Diesel (trans/Others)	HFO (NAWEC)
1993	1.03	16.17	31.31	12.52	19.79	10.38
1994	1.07	15.35	29.29	11.72	17.57	10.90
1995	1.08	12.75	23.36	9.34	14.02	11.70
1996	1.12	11.60	34.72	13.89	20.83	9.34
1997	1.15	11.52	30.79	12.29	18.5	20.28
1998	1.19	10.95	35.17	14.07	12.10	19.19
1999	1.22	13.38	42.22	16.89	25.33	21.14
2000	1.26	14.14	49.15	19.66	29.49	16.29
2001	1.30	10.09	51.63	20.65	30.98	22.14
2002	1.30	8.97	42.75	17.10	25.65	35.39
2003	1.38	14.91	43.40	17.36	26.04	

Source: Energy data

Table1.3: Installed Capacity and Power Generation

Year	**Installed Capacity MW(NAWEC)**	**Electricity Production MWh (NAWEC)**	**Installed Capacity (Solar)**
1993			240
1994			275
1995	13.9	83874	335
1996	13.9	84405	385
1997	28.3	109925	445
1998	26.8	118791	283.5
1999	26.8	128658	560
2000	26.8	116907	590
2001	46.0	146859	600
2002	46.0	163062	640
2003	NA	NA	NA

Source: Energy Dept. OP. NA= Not Available.

Renewable Energy:

Renewable energy resources consist of solar energy, wind energy and biomass. These energy forms, in particular solar and wind belong to the modern sector. Wind is being tested in The Gambia. A countrywide study on the energy potential of wind funded by ADB is in the pipeline. Solar energy is in the market and a number of companies are operating in solar energy sub-sector. They include Gam Solar, VM The Gambia Limited, Gambia Electrical Company, SWEGAM and Dabakh Malick Energy Centre. **Table 1.3** presents the total installed capacity of solar PV systems in the country. The key application of solar is in lighting, heating, water pumping, telecommunications and refrigeration.

Table1.4: 5-Year Projection of Biomass Availability as at 2004 in Metric Tons

Material	Year 0	Year 1	Year 2	Year3	Year 4
Groundnut Shells	19,900	21,300	22,800	24,400	26,100
Millet Stalks	78,500	83,200	88,200	93,500	99,100
Maize Stalks/Cobs	18,800	20,500	22,300	24,300	26,500
Sorghum Stalks	31,500	34,600	38,100	41,900	46,100
Rice Straws/Husks	6,900+	7,300	7,800	8,300	8,800
Cotton Stalks	1,270	1,300	1,330	1,360	3,400
Total	155,600	166,900	179,200	192,400	206,600

Source: Charcoal Briquetting Feasibility Study 2004.

The most important biomass resources are agricultural residues and industrial wastes of agricultural origin. The uses of agricultural residues on the farm are important and likely to impose a stiff competition for their use as household energy sources. **Table 1.4** presents estimates of the likely available quantities of these biomass resources for briquetting projected over the next five years as established in **Annex 4.1**, the feasibility of producing briquettes in The Gambia

1.1.2: Importance of the different Sectors

Table1.5 shows the percentage shares of each type of energy in the household energy basket. The importance of the different energy types, in a descending order, based on their shares of the household energy balance are fuelwood (firewood & charcoal), petroleum (kerosene & LPG), electricity (thermal) and renewable energy.

Table 1.5: Percentage Contribution of the Different Energy Sub-Sectors to the National Household Energy Balance in 2004.

Source	Percentage (%) Contribution
Fuelwood	96.96
Petroleum	1.60
Electricity	0.88
Renewable	0.56

Source: Household Energy Consumption Survey 2004

Table 1.6 shows the distribution of fuel consumption by type, quantity, value and by type of household. Fuelwood tops the list in terms of both quantity and value. The rural households consume more fuelwood than the urban household. However, whereas the rural households consume more firewood than the urban households, the latter consume more charcoal.

Both households consume more fuelwood than electricity. The urban households spend more on electricity whereas the reverse is true for the rural households. Electricity attracts the highest value.

Table 1.6 Fuel Consumption in Quantity (TOE) and Value (Dalasi) Terms

Fuel Type	Quantity in TOE			Value in Dalasis		
	Urban	Rural	Total	Urban	Rural	Total
Fuelwood	183,302.57	328,236.82	511,539.39	188,845,998	219,170,834	357,916,832
Firewood	173,501.93	326,999.76	500,501.69	179,078,747	147,436,498	326,517,245
Charcoal	9,800.64	1,237.06	11,037.70	109,767,251	71,632,336	181,399,587
LPG	2,091.48	606.17	2,697.65	67,779,394	19,644,259	87,423,653
Kerosene	1,032.16	4,741.34	5,773.50	11,095,033	50,916,573	62,011,606
Electricity	4,211.12	414.41	4,625.53	222,308,263	21,877,078	244,185,342
Biomass	2,033.45	918.85	2,952.30	21,836,927	9,867,379	31,704,307
Total	192,670.78	334,917.59	527,588.37	511,865,615	321,376,123	833,241,740

Source: Household Energy Consumption Survey 2004

Although non- indigenous resources, the petroleum products of kerosene and liquefied petroleum gas (LPG) are of important household energy value in The Gambia. The quantity of kerosene consumed is about the same as electricity but the value is much smaller. A greater proportion of kerosene is consumed by the rural household. Both electricity and kerosene are generally used for lighting. Thus one type can substitute the other. However, because of the phenomenal cost differences and availability, it is not likely to substitute electricity for kerosene in the medium- term. Cost is however, only one consideration.

Approximately the same quantities of LPG and biomass are consumed nationally and the urban households are the bigger consumer.

Table1.7: Comparative Analysis of the unit TOE cost of the various Energy Types as at 2004.

Energy	Unit Coat (D/TOE)		
	Urban	Rural	Country
1. Fuelwood	1,030.24	667.72	699.68
1.1. Firewood	1,032.14	450.87	652.37
1.2. Charcoal	11,200.01	57,905.30	16,434.54
2. Biomass	10,738.86	10,738.84	10,738.85
3. Kerosene	10,749.33	10,738.86	10,740.73
4. LPG	32,407.38	32,407.17	32,407.33
5. Electricity	52,790.77	52,790.90	52,790.67

Source: Household Energy Consumption Survey 2004

Table 1.7 shows the unit cost of each energy type both nationally and by type of household. Assuming that cost is a measure of importance as it influences demand, then the lower the unit cost of an energy type, the greater its importance. Fuelwood is thus the most important although the charcoal cost is generally an outlier but case a freak in the rural area due imputed expenditure of subsistence production. The importance of the rest of the energy types in a descending order are biomass, kerosene, LPG and electricity nationally and by type of household.

As a strategy to ensuring cheap household energy, one may be tempted to opt for the promotion of ensuring fuelwood and biomass supply. Indeed, policies or strategies pursued so far have concentrated more on this aspect than on any other. Gambia Forest Management Concept is a case in point.

LPG, renewable (biomass and solar) and electricity are all energy sources that have no or very little impact on the forest cover. Thus if the concern is deforestation, desertification and the consequent aggravated poverty, these sources deserve greater attention.

The bottlenecks that keep the cost of LPG are fairly well known. They include lack of bulk storage facilities and small parcels of imports. Technological innovations may result in bringing down the cost of renewable energy in particular solar and wind. Imported petroleum fuel to fire NAWEC's generators for electricity production is one of the major causes of the high cost of electricity. Therefore a more aggressive hydro carbon exploration programme needs to be undertaken to ease the burden of the high and escalating cost of imported petroleum products. Improvements in the management of the electricity to cut transmission and distribution losses and collect revenue due to NAWEC may all contribute to bringing down the cost of electricity. The country's participation in sub-regional and regional power and energy matters such as OMVG's hydro-power project interconnection, West Africa Power Pool and the West African Gas Pipeline may contribute to the reduction of the cost of electricity to the households.

Table1.5 shows the national household energy balance of The Gambia. Fuelwood is unassailably the most important in terms of quantity. **Table1.6** shows the consumption of and values of the different types of fuel. Fuelwood is the most consumed by both urban and rural households. However the value of urban electricity consumption is higher than the value of the fuelwood consumed by the urban households. Since the urban consumption of fuelwood in TOE is higher than its electricity consumption, the higher value of urban electricity consumption must be reflective of the very high unit cost of electricity. This also confirms the statements on the high cost of fossil fuels, which is an impediment to socio-economic development generally.

Thus, if size of percentage consumption is a criterion for importance, then fuelwood is the most important. The rest trails well behind fuelwood.

1.1.3: Institutional Set-up:

Fuelwood, petroleum products, electricity and renewable energy are the energy resources/sources employed in The Gambia. The management responsibilities for these resources/sources over-lap and involve a number of agencies. The following summarizes the key institutions and their responsibilities:

Office of The President (OP)

OP is in-charge of the overall energy portfolio. Its technical arm is the Energy Division. The Division has a Director of Energy and a Commissioner for petroleum. The former, with the assistance of his team are engaged in legal, policy, strategy and programme formulation. The Director of Energy also serves as the desk officer for NAWEC and the Geological

Department and supervises GREC. He coordinates cross-cutting issues with other stake-holders in the energy sector.

The Commissioner for Petroleum Exploration and Production manages a petroleum Data Centre, the resource base of the Commission. The Office supervises all upstream petroleum activities, and promotes the Country's hydro-carbon acreage. The Gambia National Petroleum Company (GNPC), which is recently incorporated is the national oil company of the country and is to operate like any profit-making organisation. The Geological Department assists the Commission in geological and geophysical matters. The Department of Energy Division liaises with the oil companies, LPG and renewable energy companies in areas of common interest.

Department of State for Fisheries, Natural Resources and Environment (DOSFNRE):

The DOSFNRE is responsible for the proper and efficient management of the nation's natural resources. Its technical agencies are the Departments of Water Resources, Forestry, Fisheries and Parks and Wildlife Management and the National Environment Agency (NEA). Each of the departments is headed by a director who is assisted by a team of professionals in their areas of competence. The Department of Forestry has substantial household energy responsibilities.

The Forestry Department is responsible for the management of the nation's forest resources of which fuelwood is a very important component. Fish smoking is an important economic activity which uses considerable quantities of fuelwood in the process. Thus the Fisheries Department has a direct stake in the nation's forest cover.

The Department of Water Resources is actively involved in rural water supply using solar energy (renewable). The NEA is entrusted to ensure harmony between man and his environment. The agency is therefore a stakeholder in the efficient management of the nation's natural resources and the health of the nation, green house gas and combustion related persistent organic pollutants (POPs) are all a matter of concern to NEA. Therefore NEA is a stakeholder in fuelwood.

Department of State for Finance and Economic Affairs (DOSFEA):

Apart from being responsible for the management of the country's macro-economic framework, DOSFEA is preoccupied with the flow of receipts to government. One of the main avenues of such inflows is taxes levied on petroleum products importation. This probably explains why the management of the downstream petroleum has not had a coordinated management structure at central government level. Oil companies have hitherto regulated themselves. Plans are now underway to legislate the management of the downstream petroleum sector.

Department of State for Local Government and Lands (DOSLG&L):

The technical arm of DOSLG&L, the Department of Community Development, is responsible for community mobilization and has been engaged in promoting the efficient management of fuelwood resources through the promotion of substitutes and improved end-use appliances for firewood at the household level.

All the foregoing agencies combined form the hub of the institutional set-up in the management of the nation's energy resources and by extension, the household energy resources.

1.1.4 Principles of the National Energy Policy

Energy is the engine of Socio-economic growth and development. The Gambia, however, is not endowed with abundant natural energy resources. It has forest from which the nation derives most of its energy requirements. Fuelwood has considerably a narrow range of household energy applications. It is not versatile however, its source is rapidly depleting. This trend may be difficult to arrest due to the individual nature of its causal factors. Thus the principles of the national energy policy must therefore take cognisance of all these salient factors of which the key issues are:

- Energy is the engine of socio-economic growth and development;
- Fuelwood is The Gambia's greatest energy source with limited applications and its resource base, the forest cover, is depleting very fast due to overwhelming forces.

It was in recognition of the foregoing issues and challenges they pose in the country's energy situation that the following principles were articulated as a framework for overall national energy policy planning and implementation:

1. Put in place such polices to maintain the current supply of energies. This policy is a buying – time policy. It is short – term. It means that the existing supply avenues must be managed well, with mechanism put in place to detect adverse trends and take measures to address them. The Department of Energy and the Forestry Department should take the lead in this respect.
2. Develop long-term responsive policies in line with the development needs of energy resources for socio-economic development.
3. Develop policies that facilitate the efficient allocation of scarce resources for the development of efficient and versatile energy resources.
4. Develop and put in place institutional monitoring/early warning mechanism that regularly gives information on trends to facilitate timely responses.

1.2 Demand for Household Energy

Various studies in The Gambia on energy and the forest have consistently demonstrated fuelwood as the most important source of energy in The Gambia. It is the main energy source of households. The source of the fuelwood, the forest, has been and continues to be under enormous pressure stemming from a number of factors including rapid population increase, bushfires (80%), land clearing for human settlements and for agricultural pursuits, overgrazing, and as the source of fuelwood for a swelling population. Drought has also left its mark on the country's forest landscape. The combined effect of these phenomena is unprecedented rate of deforestation and the precipitation of accelerated desertification. The national response has been steadfast including studies, programmes and projects. The studies include those by Open Shaw (1973), ORGATE (1981) and the ongoing DMCI study.

1.2.1 Factors that Influence Demand of Household Energy at the Macro-Level

The following examines the factors that determine/influence demand for energy generally and household energy in particular. At the macro level the two most important factors are population and socio-economic aspects.

Population

Table 1.8 shows that The Gambia's population grew over 400% from 1963 to 2003. The change in population density grew in the same direction as the increase in population. Although the rate of growth of the population declined from a high of 4.1% in 1993 to a low of 2.77% in 2003, it is still high enough to be of serious energy policy concern.

Table 1.8: Development in The Gambia's population dynamics

Year	Population	Growth Rate (%)	Density (Per m/Km^2)
1950	200,000		18
1963	300,000	3.85	28
1973	493,000	6.43	46
1983	688,000	3.95	64
1993	1,038,000	4.1	97
2003	1,365,000	2.77	128

Source: Central Statistics Publications

The overall effect of the population factor impinges negatively on all the factors that are said to contribute to deforestation and desertification. Thus the rate of depletion of the fuelwood resource and the demand for the resource are both increasing.

Socio-Economic Aspects:

Socio-economic factors do have fundamental macro-economic influence generally and on household energy demand in particular.

Table 1.9 Economic indicators of Relevance to Household Energy Demand

Year	GDP in 000'D	GDP Growth Rate (%)	Per Capital Income in US$
1973		-	300
1998	565150	5.8	-
1999	603882	5.7	-
2000	634478	5.4	302
2001	66124	5.3	320
2002	687281	3.61	350`

Source: Central Statistics Publications

Table 1.9 shows GDP growth rates from 1998 to 2002 and per capita incomes from 1973 to 2002. Both GDP growth rate and per capita income have not changed much over the years. The virtual stagnation of the per capital income probably better reflects this situation. This phenomenon implies that the country has experienced very little economic progress over the years. This has implications for household consumption pattern including its demand for fuelwood and household energy-related services.

Table 1.10: Distribution of GDP by kind of Economic Activity at Factor Cost (Constant Prices 1996) in 000'D

Economic Activity	Year				
	1998	**1999**	**2000**	**2001**	**2002**
1. Agriculture	128029	178110	196582	214997	20055
1.1. Groundnut	26328	44069	49471	54144	47647
Total Industry	197961	248758	269372	290476	281098
Total Services	367189	355124	365107	377648	406183

Source: Central Statistics Publications

Table 1.10 presents a disaggregated picture of **Table 1.9** to focus the energy demand prospects of the rural sector. Agriculture continues to be the most important economic activity in The Gambia. It is the sector that contributes most to the country's real export earnings (groundnuts) and is responsible for about 80% of employment. (people that are engaged up to a period of three months and above per year). The agricultural sector, especially groundnut production has stagnated over the recent past. This has a great bearing on rural incomes and limits their abilities to demand for goods and services. The low level of real export earnings influences the country's ability to diversify and expand its non-fuelwood imported energy resources.

1.2.2 Factors that influence the demand for household energy at Micro-Level:

The fore-going examined factors that influence aggregate demand and economic development. The ensuing analysis examines the factors that influence demand of the various energy resources at the micro/household level.

Fuelwood comprising firewood and charcoal is the most important source of household energy. Studies have shown that it contributes about 97% of the household total energy requirement. **Table 1.11** provides an evaluation framework for the demand for household energy including fuelwood.

Fuelwood is the dominant form of household energy for preparing food, heating and ironing for both urban and the rural households. However, the rural households use fuelwood for the said purposes more than the urban households. For the purpose of cooking, heating, ironing and brewing attaya or tea, fuelwood is unassailably the most important. Its demand for these purposes is unchallenged.

For household lighting, kerosene is the most important for the rural households while electricity is more important for the urban households.

Table 1.11: Relative Importance of Various Energy Sectors in the Household

Energy Uses In Percentages

Energy Form	**Pop. Segment**	**Cooking**			**Other Uses**			
		Breakfast	**Lunch**	**Dinner**	**Ironing**	**Heating**	**Attaya/ tea**	**Lighting**
Fuelwood	Urban	57	95	80	87	47	73	-
	Rural	96	96	85	91	91	88	-
Kerosene	Urban	-	-	-	-	-	-	5
	Rural	-	-	-	-	-	-	57
Electricity	Urban	-	-	-	-	-	-	52
	Rural	-	-	-	-	-	-	-

Source: DMCI Energy Consumption Survey 2004

At the current low level of economic development with very low incomes and low real export earnings, the prospects for a switch-over to alternatives such as electricity are bleak. Therefore demand for fuelwood is likely to continue to grow with the growth of the population. This will further aggravate the pressure on the forest cover and accelerate deforestation, desertification and loss of flora and fauna.

***Firewood*:** Attributes can and do influence choice of fuel and therefore its demand. The findings of the DMCI Energy Consumption Survey (2004) provide a basis to draw conclusions about the influence of the attributes of energy resource on its demand.

Table 1.12: Percentage Distribution of Households by Attributes of fuelwood

		Attributes (%)	
Type of Energy	**Population Segment**	**Desirable Attributes**	**Undesirable Attributes**
Fuelwood	Urban	41	39
	Rural	51	42

Source: DMCI Energy Consumption Survey 2004

Table 1.12 summarizes households by firewood attributes. Although the scores on the undesirable attributes are high in both urban and rural sectors, the ratings are higher on the positive attributes for both sectors. The net effect is positive which may connote a positive demand for firewood.

Charcoal: The production of charcoal, a derivative of fuelwood, was banned in 1980 because of its negative impact on the forest cover. However, the fuel continues to be used with supply coming partly from Cassamance and partly sourced from clandestine local production **Annex 4.2** provides a review of the charcoal sector**.** It is used by about 88% of the urban household and by 81% of the rural household. Factors such as price, frequency of purchase and availability are crucial in the demand for charcoal. The urban and rural households tend to be evenly divided on certain values. Whereas the majority of the urban population believes that the production should be legalised the rural households think otherwise. The emphases on the attributes are also different.

Table 1.13: The various attributes of the different forms of household energies

	Petroleum Products						Renewable			
	LPG		Kerosene		Electricity		Solar		Biomass	
	U	R	U	R	U	R	U	R	U	R
Users	56	21	19	70	64	11				
Non-users	44	79	81	30						
Duration	32	33			5	4				
Brewing Attaya	30	20								
Cost			D1.81	D2	D310	D31				
Attributes	+	+	35	51						

			55	50						
Mode of Payment					94	35				
Awareness							40	36	40	35

Source: DMCI Energy Consumption Survey 2004

Petroleum Products

These are modern sector energies. They are all imported. **Table1.13** summarizes some of the common demand determinants of these modern sector energies.

Liquefied Petroleum Gas**:** LPG is used more by the urban households than the rural households. The bottles are available in 25, 12.5, 6 and 3 kilos. Taking their average, 11.5kg, the frequency of purchase is 32 and 33 days for urban and rural households. The frequency of purchase is a key determinant of demand.

Kerosene**:** Kerosene is mostly used by the rural households although it costs more there than in the urban areas. Its strong use is a measure of its higher demand in the rural household driven by its relative price and availability. Its negative attributes are strong in both types of household suggesting an inclination to reduce demand if suitable alternative is available.

Electricity

Table 1.13 summarizes some of the important demand determinants of electricity. Urban households use more electricity than rural households and spend a lot more on energy. Although the high cost is a disincentive to demand, its positive attributes and availability in the urban areas probably explain its greater use by the urban households. In addition to availability, affordability may be another factor of demand in favour of the urban households vis-à-vis the seasonal nature of rural household incomes. The duration in terms of period of availability of electricity, of 5 and 4 hours per day for the urban and rural households respectively is a reflection of the suppressed demand situation.

Renewable Energy Sources

***Solar*:** Although there is considerable awareness about solar energy and solar appliances, very few of those who are aware use them. This may be out of cost consideration since their capital costs are generally high. Thus high cost is a disincentive to demand.

***Biomass*:** Saw dust is the most important biomass used by the urban households and pay on average, D0.39 per day. The rural households use agricultural residues and straw. Expenditure reported by the users are, straw D2 per day and agricultural residues users spend D1.2 per day.

Summary of Household Energy Demand Equation

The fore-going analysis of demand at both the macro and micro levels provides an insight into the key determinants of household energy and their inter-relationships. The ensuing summarizes these determinants and relationships.

High population growth impinges negatively on the forest cover. It creates demand for land for human settlements and agriculture, which are claimants on the forest cover and thus availability of fuelwood. This energy resource is becoming scarce while its demand is increasing. This trend is demonstrated in the consumption tables given earlier in this study.

The Gambian economy has made little or no improvement in the real income terms over a long period as indicated by trends in the per capita income in **Table 1.9**. Agriculture is the greatest employer. Agricultural incomes have more of less stagnated. Therefore reliance by households on fuelwood has continued to remain the same. Consequently, there has been almost no movement to other energy substitutes. The same income constraints affect the ability of the energy companies to expand to make modern energy both accessible and affordable for both the urban and rural households.

At the micro level, fuelwood is the energy source most commonly used in food preparation in both urban and rural households. It is also the most important energy source for heating and ironing. Thus in the absence of a serious contender, fuelwood is the most important household energy source.

Demand for electricity for lighting is the most important application for the urban households whereas kerosene is the most important for the rural households.

Electricity and the other modern energy sources have a long way to develop to compete fuelwood. Cost is an important demand determinant. Enhanced incomes, reliability and competitive prices may provide the condition for resort to alternatives. Legislation alone will not do it.

1.3: Supply of Household Energy

The supply pattern of the two broad groups of indigenous and modern forms of household energy types are largely influenced by the same set of determinants of supply differently. While the supply of the indigenous group tends to be mainly influenced indirectly by the impacts of these supply determinants on the resource base, the supply of the modern group tends to be indirectly influenced by their impacts on the capacity to import.

Fuelwood

The key factors that have shaped and continue to drive the fuelwood supply are the forest cover, population and public forest policy including institutional, legal and regulatory frameworks of forest management.

The situation of the fuelwood is detailed in sub-section 1.1.1 above. The Gambia's forest cover has gone through serious degradation over the past 50 years. The closed forest has virtually disappeared. It shrank from over 60% of the total land area to 0.7% from 1946 to 1998. The total forest cover also shrank from over 80% to 40% over the same period.

The population grew from less than 200,000 to more than 1,360,000 from 1950 to 2003. The population puts pressure on the forest cover in a multitude of facets. The population requires land for agriculture to feed itself. It requires land for settlement and it requires fuelwood to meet its energy needs. Land for agriculture, land for settlement and fuelwood are met at the expense of the forest cover. The situation of the forest is further aggravated by over-grazing, drought and bushfires.

Thus under the weight of mounting anthropomorphic pressures, the forest cover dwindled as there were no concerted and conscious efforts to counteract the effect of these pressures. The Gambia's fuelwood base has therefore eroded resulting into precarious supply prospects.

Attempts to salvage what remained of the country's forest cover commenced in the second half of the 1970s. The initial approach was to prevent bushfires and promote natural forest plant regeneration. That policy was inadequate to cope with the role of fuelwood, agriculture, human settlement as the major contributors to deforestation. The awareness of the threat to fuelwood supply came much later with the ban on charcoal in 1980.

Since then a number of complementary and mutually reinforcing initiatives have been taken and continue to be made. Surveys were conducted that enable a better understanding of prevailing conditions of the country's vegetation, as a basis for redressing recommendations. These led to new policy directions, including new legislations, strategies, programmes and indeed projects through mainly the support of the Federal Republic of Germany.

One particular policy strand specific to fuelwood energy question was ensuring sustainable fuelwood supply to the rural and urban populations. In pursuance of this policy objective, The Gambia Forest Management Concept (GFMC) was conceived as an overall forest management strategy to sustain fuelwood supply through :

- Community forests
- Forest parks
- State forests
- Forest plantations
- Private forest plantations

In conclusion the hopeless nature of the fuelwood supply prospects can be reiterated in the following terms: that the country imports about 60% to 80% of its fuelwood from Cassamance; whereas the population is rapidly increasing the fuelwood supply base is decreasing; it is therefore unlikely that the fuelwood supply from the country's forest resources would ever meet its demand.

Petroleum products

The main petroleum products of direct household energy use are kerosene and LPG. Although all these are imported modern household energy types their supplies are influenced by similar factors differently.

Kerosene has been used as household energy for lighting over many years. Its share of household energy balance is 1.00% of which about 0.82% is consumed by rural households and the urban households consume 0.18%. Despite its wide spread use especially by the rural households, it is considered to be dirty and smelly. This generally unfavourable perception may be one single factor that will limit its potential as a substitute for fuelwood and therefore constrain its supply in the future.

Kerosene suffers the same institutional and legal constraints as electricity. The department responsible for energy matters is also responsible for kerosene. There has not been any clear-cut demarcation of responsibility between the Department of State for Finance and Economic Affairs and the department of state responsible for energy with consequent erratic price increases. However, initiatives are underway to put in place downstream legislation. This legislation will hopefully spell out the duties and obligations of the parties. The private oil companies that import the product regulate themselves.

LPG has a favourable public perception. However, it is considered to be expensive especially its appliances as well as being dangerous. Its share of household energy balance is about 0.47% and the urban households consume 78% of this whereas 22% is consumed by the rural households.

During the first half of 1990 the European Union (EU) funded a butane gas project as a viable substitute for fuelwood. The project yielded limited results. The cost of appliances and the problems connected with refilling are said to be the major difficulties for its lack of success. These problems were compounded by lack of bulk storage facilities and imports continued to be in small parcels that result in high cost of LPG. These supply-side issues have been major limiting factors to increased consumption of LPG.

Like kerosene the institutional and legal frameworks of LPG are major obscurants in the expansion of its supply. The department of state responsible for energy matters is in charge of LPG matters. At the operational level, the LPG companies are responsible for bringing the gas to the consumers. These companies include Gam Gas, M&C, Touba Gas and some of the oil companies. There is very little coordination between the line department and the private operators.

Like the downstream petroleum sector, there has not been any legislation to provide for the importation, transportation, storage and distribution of LPG with adequate environmental safety and health provisions and an incentive regime to encourage adequate supply. Like other petroleum products, the effect of huge imports has huge foreign exchange implication. LPG can be a significant substitute for fuelwood, and thereby play a role in arresting the pressure on the forest cover.

Electricity

Electricity is probably the most important energy of the modern sector. The main source of electricity supply comes from NAWEC facilities. Other sources are private generation, solar, car batteries, flash lamps etc. The share of electricity in the national household energy balance is 0.8%. The urban households consume 63.9% of the total electricity supply while the rural households consume 11.4%.

National electricity supply has experienced incessant problems over the years. The problems include management, generation, transmission and distribution. Human capacity has been also a major constraint in the development of the power sector. The additional investments in increasing the generating capacities from 13.8mw to 28.3mw and to 40mw in 1997 and 2001 resulted in only short-lived increases in supply to the consumer. Load shedding is the rule rather than the exception in power supply. The ability of NAWEC to expand its generating capacity in the immediate term is very slim.

The institutional and legal frameworks have been the most restraining factors of supply of electricity. The national electricity company NAWEC, is a state company. The company has three mandates – power generation, transmission and distribution, water and sewage. It has a board of directors, a managing director and directors who are assisted by division managers. NAWEC is under the purview of the department of state responsible foe energy matters which is presently the Office of The President. This department is responsible for the overall policy matters on power generation. The day-to-day management is the responsibility of the management of NAWEC. The public nature of the company's institutional and legal frameworks have had the undesirable effect of crowding out potential private investment and management resources thus limiting the scope of expanding supply.

The structure of the electricity tariff is influenced by two major cost elements: fuel and labour bill. NAWEC does not determine these costs independently. These decisions are reached through directives from the departments responsible for finance and energy, which will often weigh in tracer of budgetary and political considerations. Thus the tariff structure does not reflect the cost of electricity generation and this is partly the explanation of NAWEC's problems of under-capitalization and difficulties to meet its operational costs much more expand generation capacity.

The legal framework has recently been reformed and the new electricity legislation provides for private participation. The degree of freedom of the private investor to determine the tariff structure will determine the private sector's willingness to invest in the sector. However, this freedom may not be enough. The ability of a significant potential customer clientele must be available to allow the business to break-even and invest in additional generating capacity to expand supply. The most recent agreement that allows Al Kharafi and Sons to participate in NAWEC could open a new chapter in the history of power supply in the country.

Renewable Energy

The main renewable energy sources are wind solar and biomass. Their supplies are relatively free from institutional and legal constraints of the other modern energy types**.**

There is considerable public awareness of solar energy. It is adopted by a number of households especially the rural households. The public perception is generally receptive. According to DMCI study, 61.6% of the solar energy users were rural households whereas 38.4% were urban. Cost of appliances is reported to be the biggest factor hindering the adoption of solar energy.

Solar energy is in abundant supply throughout the year. However, this energy form is slow to fully enter the household energy market due to the lack of adequate research to improve solar technologies. It is probably the cleanest form of energy with almost no negative impact on the environment and therefore an ideal substitute for fuelwood and imported petroleum products.

Biomass has great potentials as a substitute for fuelwood. It is estimated that it has the potential to contribute about 30,000 TOE to the household energy balance. Apart from saw dust, the common biomass resources in the country are agricultural resides. Although the supply of all biomass resources is exogenously influenced by the vagaries of the climate, that of agricultural residues is more susceptible. The agricultural residues also have a number of important alternative uses on the farm such as animal feed and organic manure which may limit their supply severely.

Biomass can be made into briquettes. The public perception of briquettes in the past has not been very favourable as it was perceived as being inconvenient and smoky. This image can be addressed through improving the product and indications from the sectoral study on feasibility of producing briquettes (**Annex 4.1**) are that this is possible at highly competitive product price.

There is no specific legislation in place concerning renewable energy production. The need for one in the form of a total ban on the production and import of wood charcoal will be crucial in the successful establishment of a briquetting plant and promotion of briquettes as substitute for wood charcoal.

The institutional and legal constraints of renewable energy sources are relatively less stringent. Renewable energy matters are under the purview of the department of state responsible for energy matters. The lead technical arm of the department, the Renewable Energy Centre (GREC) is very weak to adequately respond to the needs of the sector. A strengthened GREC may greatly enhance the supply of solar energy appliances at affordable prices.

1.4: Ongoing Activities in the Household Energy Sector

The Gambian household is the dominant user of energy produced in the country. It uses more than 90% of the fuelwood that constitutes more than 80% of the nation’s energy balance. About 66% of NAWEC’s electricity generation is consumed by households. Thus all on-going initiatives in the energy sector are of relevance to a household energy strategy.

Electricity Energy Source

Rural Electrification Project: The project targets 46 towns and villages in the rural Gambia to supply electricity from six small power stations.

Legislative Reform: Electricity Law is being finalized at Cabinet level.

Petroleum Products

LPG Project (Sea Terminal and Storage Facilities)**:** The project expects to bring the price of the 3kg bottle to D9 and that 7000 tonnes LPG would be equivalent to 80,000 TOE fuelwood. That will constitute a huge saving on fuelwood. This is a private initiative that has a power generation fired by LPG component. Part of the electricity generated would be sold to NAWEC

New Petroleum Storage Facility**:** Government initiated a number of studies on the subject. A feasibility study has been carried out, a project location is identified and Government is promoting the project for execution. The project is expected to fulfil the condition of future capacity needs and human and environmental safety.

Downstream Legislation**:** Government has initiated steps to put in place new legislation on the downstream sector.

Petroleum Exploration and Production**:** The Petroleum Act (2004) on exploration and production has already been enacted. It governs the administration and management of the upstream sector of the petroleum industry. It has a regulation component. This will facilitate the implementation of the provision of the Act.

A very promising petroleum prospect has been identified in the ultra deep waters of The Gambia by a 3D seismic survey. This is followed by a 3D follow-up seismic undertaking. The Gambia is promoting the prospect. It is also promoting onshore seismic/exploration. Gambia's hydrocarbon data is stored at Western Geco where interested parties can access and or view the data.

Sectoral Studies

A number of sectoral studies of which this is the culmination are being sponsored by EDF-supported CILSS regional project. These are:

1. National energy consumption survey;

2. Charcoal sector review;

3. Charcoal briquetting study ;

4. Review of the experiences with community based natural resources; and,

5. Household energy strategy.

Fuelwood Management Issues

Forestry Programme: A number of fuelwood related issues are currently being undertaken within the framework of the national forestry programme. These are:

- Forestry policies and legislation;

- Forestry inventory programmes ;

- Natural forest management;

- Community forest management concept; and

- Model for management of natural forest parks, community forest reserves.

Demand-side management actions**:** These include mainly development and promotion of improved woodstove and awareness creation and, promotion of alternative fuels and technologies to reduce pressure on fuelwood.

Renewable Energy

Renewable Energy Research: The Gambia Renewable Energy Centre (GREC) and Agricultural Research Institute (NARI) execute renewable energy research programmes with a view to advising the Government on:

- Renewable energy matters
- Preparation and implementation of renewable energy projects
- Prepare plans on renewable energy development and promotion
- Promote renewable energy systems etc.

Renewable Energy Study: The African Development Bank (ADB) funded renewable energy study (2004) is currently under-way.

2: PERSPECTIVES AND MAIN CONSTRAINTS

2.1 Demand Growth

The Gambia has a very narrow indigenous energy resource base. The only indigenous energy source is fuelwood. It is also the dominant energy both in the national and household energy baskets.

Fuelwood is subject to a number of pressures. The rapid population increase has given rise to a number of related phenomena, which together exert heavy pressure on the forest cover. The need for human settlement, expansion in agriculture and road infrastructure, over grazing and the increased demand of the population all add-up to erode the energy supply base of the country's forest cover to meet the increasing demand of the population. These factors provide the ideal conditions for consumption of the forest capital leading to deforestation.

Petroleum products including LPG are imported and are a very heavy burden on the country's meagre foreign exchange resources.

The development of renewable energy (wind, solar and biomass) is progressing. Renewable energy sources have the potentials to contribute substantially to the household energy balance. Thus the household energy perspective is full of challenges and opportunities. The constraints are however daunting.

2.1.1: Population Growth

Energy resources are central to socio-economic development. Development is largely dependent on the availability of energy, its adequacy and accessibility. The Gambia is an energy poor country over 80% of its energy requirements come from fuelwood. The households consume over 96% of fuelwood energy. We have noted earlier that The Gambia's forest cover has gone through tremendous degradation. There is strong correlation between forest depletion and population growth. The following summarizes the population aspects that influence household energy demand:

Table 2.1: Population Dynamics

				Population		
Year	**Fertility Estimate**	**Infant Mortality**	**Immigration**	**Size**	**Increase**	**Growth**
1963		-	35555	280000		
1973	6.4	-	52002	400000		
1983		167	60796	547000		
1993	6.04	84	134118	1038145		4.2
2003			-	1364570	31.4	2.77

Source: Central Statistics (2004)

Dynamics of The Gambia's Population

Table 2.1 shows the dynamics of The Gambia's population. Factors that have played significant roles in determining the nation's population are:

- Persistent high fertility among women ;
- Decline in infant mortality ; and,
- Increase in immigrants.

The combined effect of these factors is one of rapid population increase over the decades, as revealed by the population growth. This rapid increase in population puts additional pressure on the country's very limited energy resource, fuelwood and thus accelerates the degradation of our forest cover. Indeed, this is reflected in the huge imports from Cassamance estimated between 60% and 80% of national consumption. The depletion of The Gambia's forest cover is captured in Open Shaw's survey (1973) that revealed that the country's woodland shrank from 62.2% in 1948 to 7% in 1968.

2.1.2 Current Inter-fuel Substitution

Fuelwood accounts for over 96% of the household energy needs, electricity 0.88%, kerosene 1.09% biomass 0.56%. Note that electricity consumption includes electricity derived from solar energy. All the possible substitutes contribute very little to the household energy basket. The challenge then is the possibility to increase substantially the percentage contribution of these other sources to the basket since their combine contribution is less than 4% of the total household energy need. The following examines these other energy resources for potential inter-fuel substitution:

Petroleum Products

The Gambia is not endowed with petroleum products associated with the modern economy. The Gambia therefore, imports all its petroleum products requirements to run its modern sector, transportation, electricity generation etc. The major petroleum products used for direct household energy production are kerosene and liquefied petroleum gas [LPG]

Kerosene contributes 1.09% to the household energy basket. It is mainly used in the rural homes for lighting as these do not have access to electricity. It is relatively cheaper and is used in lighting. Kerosene stoves are in the market. However, they have not penetrated the market the cost of the stove may be beyond the reach of the average household. Kerosene is not popular because the public perception is that kerosene is untidy, smelly and dirty. Petroleum products are imported in small parcels, which results in high import cost. While it is not a favourite substitute for any of the two fuelwood energy resources, its potential substitute, electricity is currently either not available and/or inaccessible to the majority of the population.

LPG is an extremely inflammable gaseous petroleum product. Its share of the household energy balance is 0.47%. The players in this market segment are small local gas companies-

Gam-Gas, M&C Gas and Touba Gas. The oil companies have more or less withdrawn from the LPG market.

Electricity

Electricity contributes 0.88% to the household energy basket and about 1% to the national balance. The low contribution is attributed to a number of factors.

Under-capitalisation has constrained NAWEC from increasing its generation, transmission and distribution capacities. It has also placed limitations on the company's ability to execute a proper maintenance schedule. No payment by big consumers especially Government, has created operational problems for the company to an extent that fuel purchase to run the existing generators sometimes prove difficult. NAWEC also faces both management and human resources capacity constraints as well as institutional weakness.

Another dimension to the use of electricity as source of household energy is low household incomes. The average family size is 10-15 persons. Rural incomes are seasonal. Thus even where the electricity supply is regular and adequate, the ability to pay can create problems.

Given the current contribution of 0.88% of the household energy basket, it will require huge investment to increase its share to an appreciable level. The household is the main consumer of NAWEC's output. Its clientele is 30267 customers (source SIMI, 2004) against 158,489 national households (2003 census). With NAWEC's projected growth of 6-8.5%/annum, it will take a long time to reach the whole population which is growing at a rate of 2.77% (2003 census).

The Gambia ranks among the world's poorest countries where per capita incomes have stagnated around $300 per annum. With the strong correlation between energy consumption and economic prosperity, electricity for all has a difficult challenge.

Petroleum to power NAWEC's generators is a source of great concern as imported petroleum products are a drain on the country's meagre foreign exchange earnings. Thus access to cheap petroleum products is a major constraint.

The foregoing factors combine to keep the price of electricity beyond the means of the majority of the population which undermines its current potential inter-fuel substitutability. In the long-run however, electricity being the most versatile energy may be the answer to the household energy needs.

Renewable Energy

Wind, solar photo voltaic, solar thermal, biomass, i.e biogas and gasification all belong to the renewable energy category. The share of renewable energy that is biomass, to household energy is 0.56%. The contribution of solar energy is captured in the electricity components.

The main constraint of solar appliances is cost, which is beyond the reach of the average household. Technological improvement in equipment science will be needed to bring down the cost. Biogas and gasification have been tried without success.

The constraints of the renewable energy sub- sector are:

- Rapid depletion of biomass and natural resources;
- Socio-economic acceptability of renewable energy;
- Inefficient marketing of renewable energy systems; and,
- Lack of trained professionals and technicians;

DMCI (2004) found that household energy balance in 2004 was 39% higher than the 1995/01 average. Kerosene increased by 17% the rest grew by more than 35%. LPG and biomass increased by 242% and 2862% respectively.

The substitute for fuelwood in cooking, lighting and heating are solar, LPG and biomass. It is estimated that biomass has the potential to contribute about 30,000 TOE to annual household energy balance. Changes in the shares of the different energy types in the household energy balance are reflective of the extent of inter-fuel substitutions.

2.1.3 Performance of Equipment and Methods Used

Use of Appliances

Table 2.2 provides detailed percentage distribution of sample households by use of firewood appliances. The three-stone is the most commonly used for all cooking (60%) followed by Furno Nufflie, 17% and Sinkiri Kuto 15%. It may be recalled that Government, through the Department of Community Development with the assistance of donors promoted the use of energy efficient household cooking appliances, Nufflie and Sinkiri Kuto.

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Table 2.2: Percentage Distribution of Household by use and Basic Material of firewood appliances by Sector:

Use/ Material		Appliances													
		Sinkiri kuto		Furno Nufflie		Three Stones		Pot with inbuilt stand		Kumba Gaye		Firestone oven		Others	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Use	**All cooking**	**25.6**	**10.0**	**34.7**	**8.6**	**23.9**	**79.0**	**2.2**	**4.4**	**7.5**	**2.3**	**2.5**	**0.1**	**2.8**	**0.1**
	Some foods	**3.9**	**2.9**	**2.2**	**1.4**	**0.6**	**3.7**	**0.6**	**0.6**	**1.1**	**0.1**	**0.0**	**0.1**	**0.3**	**0.0**
	Only Tea	**1.9**	**2.6**	**3.3**	**1.0**	**1.4**	**3.9**	**0.0**	**0.1**	**0.3**	**0.1**	**0.0**	**0.0**	**0.3**	**0.0**
	Parties only	**0.0**	**0.0**	**0.0**	**0.6**	**0.0**	**0.7**	**0.0**	**0.1**	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**

	Only Heating Water	**1.1**	**2.0**	**2.8**	**0.9**	**1.7**	**4.7**	**0.0**	**0.3**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	Others	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Basic Material	**Iron**	**10.0**	**5.7**	**17.5**	**4.3**	**0.8**	**2.4**	**0.6**	**4.4**	**1.1**	**0.4**	**0.0**	**0.0**	**8.0**	**0.0**
	Metal	**17.2**	**8.0**	**13.7**	**6.9**	**1.1**	**3.3**	**1.4**	**0.3**	**8.1**	**2.2**	**0.0**	**0.1**	**1.4**	**0.0**
	Clay	**3.3**	**2.1**	**1.1**	**0.0**	**2.2**	**6.6**	**0.3**	**0.3**	**0.0**	**0.0**	**0.3**	**0.0**	**0.0**	**0.0**
	Brick	**1.7**	**1.1**	**0.3**	**0.0**	**15.6**	**14.0**	**0.3**	**0.6**	**0.0**	**0.0**	**1.9**	**0.1**	**0.0**	**0.0**
	Others	**0.3**	**0.4**	**0.3**	**0.0**	**7.8**	**66.0**	**0.3**	**0.0**	**0.0**	**0.0**	**0.3**	**0.0**	**1.1**	**0.0**

Key 1 = Urban and 2 = Rural
Source: DMCI Consumption Survey 2004

Energy efficient firewood cooking appliances have many advantages to the household. Using less firewood means for the subsistence producer less time spent in collecting the firewood. The extra time could be spent in economically gainful activities. For the buyer, it means spending less on firewood and that is a saving. For the ecology it would appear the awareness creation is not adopted as an ongoing activity and consequently the adoption rate of energy saving firewood cooking appliances is low. The greatest constraint may therefore be awareness creation as an ongoing process.

Table 2.3 presents detailed distribution of households by use of wood charcoal appliances. The urban households use Furno Jambarr for cooking, making tea, heating water and cooking some foods more than the rural households. It is only in other uses that the rural households score higher than the urban households. The same trend is observed in the use of Furno Nufflie, exception being in brewing tea and parties

Table 2.3: Percentage Distribution of Households by use and Material used in Making Charcoal Stoves

Use/ Material		**Appliances**					
		Furno Jambarr		**Furno Nufflie**		**Others**	
		Urban	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
Use	All cooking	10.9	3.0	30.6	11.0	4.4	2.3
	Only Tea	9.8	5.5	7.6	12.3	3.0	35.9
	Only heating water	6.3	1.6	10.7	4.4	3.0	9.4
	Some foods	3.5	3.2	7.3	3.8	1.8	1.2
	Parties only	0.0	0.2	0.3	1.3	0.0	0.0
	Others	1.9	5.0	1.6	0.9	8.3	20.8
Basic Material	Iron	13.9	29.7	25.9	11.2	0.0	0.0
	Metal	33.4	45.1	65.0	51.2	49.2	94.3
	Clay	0.6	0.0	4.4	0.0	0.0	0.5
	Brick	0.0	0.0	0.0	0.0	0.6	1.2
	Others	2.5	2.5	0.0	0.0	0.6	6.4

Source: DMCI Consumption Survey 2004

It is significant that the use of the two charcoal stoves is more wide spread among the urban households in cooking. Furno Nufflie is most widely used by the urban households in cooking. The high dependence of urban households on charcoal for cooking as reflected by the relatively high percentage distribution should be of primary policy concern. Charcoal was banned in 1977 and it is still extensively used. Indeed, it is publicly marketed. The planned introduction of briquettes may face serious marking challenges from charcoal.

About 70% of the rural households and 19% of the urban households use kerosene. **Table 2.4** shows the distribution of the use of kerosene appliances between the two classes of households. Hurricane lamp is used by 85% of the 487 rural households surveyed. The two household kerosene users spent on average, D1.81 and D2.00 per day respectively.

Table 2.5 on solar cooker stove reveals that the awareness level of urban and rural households is below 50% and that although the most important source of information is the radio, less than 22% reported to have received their information through that channel. The technology of solar cooker stove is not adopted by the greater majority of those who are aware of the technology.

Table 2.4: Distribution of Households by use of Kerosene Appliances

Variable		**Appliances**											
		Wick stove		**Pressure stove**		**Tomato can lamp**		**Hurricane lamp**		**Pressure lamp**		**Others**	
		Urban	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
% household owners		4.3	0.2	0.0	0.2	0.0	0.2	87.1	84.8	0.0	0.2	2.9	7.6
Hours of use/ refill		37	12	0.0	4	169	2876	3	12	0	0	8	300
Amount of Last Purchase "D"		57	20	0.0	10.5	113	1618	0	0	0	0	5	169.2
No. of Days use		5	45	0.0	4	41	705	950	3795	0	0	4	65
% of household Purchasers	Cup	2.9	0.0	0.0	0.0	2.9	22.0	0.0	11.5	0.0	0.2	0.0	2.3
	Bottle	0.0	0	0.0	0.0	0.0	0.4	7.1	2.5	0.0	0.0	0.0	0.0
	Liter	1.4	0.2	0.0	0.0	0.0	0.0	40.0	16.6	0.0	0.0	0.0	0.0
Average Hours of use/refill		12.3	12	0	4	42	23.2	0	0	0	0	4	14.29
Average Expenditure/Last Purchase "D"		19	20	0	10.5	37	13.3	0	0	0	0	5	8.46
Average No of Days use/Purchase		1.67	45	0	4	10	5.75	16.1	9.37	0	0	4	3.1

Source: DMCI Consumption Survey 2004

Table 2.5: Percentage Distribution of Households by Awareness, Source of information and use of Solar Cooker Stove

Variable		**Sector**	
		Urban	**Rural**
Awareness	Aware/ Heard	39.7	36.3
	Not Aware/ Didn't Hear	60.3	63.7
Source of Information	Radio	13.3	21.3
	TV	10.0	4.6
	Neighbours	7.8	6.4
	Family friends	6.9	5.3
	Others	1.9	0.9
Use	Users	0.6	0.4
	Non- Users	39.2	35.9

Source: DMCI Consumption Survey 2004

2.2. Supply Growth

The growth of supply of household energy especial fuelwood is driven by a host factors. Key among these factors are the institutional and regulatory arrangements of producers and suppliers, effectiveness of the control mechanisms in place and extent of decentralization of resource management responsibilities**.**

2.2.1 Institutional and Regulatory Aspects

Energy management spans over a spectrum of both public and private agencies. The management of specific forms of energy depends on the nature of the source. However, the overall management falls within the purview of the Office of The President.

Fuelwood

Fuelwood has the largest share of both the national energy and the household energy balances. Its source is the forest and by virtue of this relation, its administration as a produce of forest resource falls under the purview of the DOSFNRE as the line department of state responsible for forestry affairs. The Forestry Department is the technical organ responsible for technical advice as well as operational, administrative and managerial aspects of forestry matters.

The Forestry Department was re-structured in1995. It underwent further re-structuring in 2002 to enable the organisation the flexibility to respond to the new Local Government Act that empowers local governments to manage their own natural resources. The new structure of the Forestry Department is as follows:

- Headquarters with its functional units ;
- Divisional Administration with powers on staff posting, planning and revenue collection etc;
- Administrative circles; and,
- Implementation Areas.

The Forestry Department leans on the Forestry Act of 1998 and regulations and the new Forestry Policy (1995-2005) in the administration of forest matters. Some of the salient features of the policy are the development of 30% of the total land area into forest, of which, 75% should be managed and protected to increase the forest resource base forest rehabilitation and the establishment of fast growing plantations and woodlots. The 30% forest land will be achieved through a number of actions including:

i. Promoting The Gambia Forest Management Concept (GFMC);

ii. Promoting Community Forest (CF);

iii. Promoting the development of forest plantation; and,

iv. Educating the public on the importance of forest resources.

***Commercial Trade in Fuelwood*:** The Forestry Act has provision for the regulation of the movement of forest produce. It requires producers and vendors of fuelwood to be in possession of valid licences issued by a competent authority. In addition, every transport load must be accompanied by a valid receipt and a removal permit. The Act also requires a producer to employ not more than three assistants to a licence holder; only dead trees are allowed to be cut; and the truck loads and the number of licences to be issued per division, are regulated.

Table2.6: Commercial Fuelwood trade (m3) Division

ear	WD	LRD	CRD	NBD	URD	Total
1996	4243.54	9254.76	2382.80	306.85	1388.40	17576.35
1997	3858.65	7607.45	3689.79	326.93	2269.85	17752.67
1998	14977.10	5653.94	13326.81	330.50	4942.25	38930.60
1999	28891.26	5479.12	9048.69	359.82	1992.07	45770.96
2000	29467.34	8236.71	78447.42	267.48	2004.84	118423.79
2001	32874.89	68450.52	5539.98	401.11	3189.42	48850.92
2002	30942.56	12286.64	7879.15	398.42	1382.25	52889.62
2003	36765.72	11987.62	8256.73	349.32	2298.79	59658.18
2004	29,156.34	8,459.79	6,845.52	2,98.47	1,649.89	46410.01

Source: National Energy Policy,2004.

Table 2.6 shows the commercial trade in fuelwood by administrative divisions. Note that WD and LRD are the most active in terms of volumes traded

***Structure of the Firewood Market*:** The firewood market has many actors from production to end consumer. **Table 2.7** shows the actors and their percentage distribution.

Table 2.7: Structure of the Fuelwood Market in Percentage of Actors

Actor /Source	**Sector (%)**	
	Urban	**Rural**
Producers	4.7	28.8
Market Vendors	19.0	17.0
Retailers	47.7	20.0
Roadside producers/vendors/retailers	23.7	20.5
Others	4.9	13.7

Source: Gambia Forestry Revenues and Budgetory Requirements June 1994

Table2.7 shows that the producers are the main source of rural household firewood, followed by roadside producers/vendors and retailers. Retailers are the most important source for urban supply of firewood.

Table 2.8: Percentage Distribution of Fuelwood Cost Among Actors

	Producer	**Wholesaler**	**Retailer**
Licences/royalties	2	4	1
Transport	51	52	0
Labour	47	0	0
Wood	0	40	96
Others	0	4	3
Total	100	100	100

Sources: SIBI (Feb. 2004)

Table 2.8 shows the percentage distribution of production cost among the producer, wholesaler and retailer and **Table 1.8** shows the price structure of fuelwood in Dalasis /$m^{3.}$

Table2.9: Price Structure of Fuelwood Production in Dalasis /m^3

	Producer	**Wholesaler**	**Retailer (KMC)**	**Retailer Banjul**
Licences	31.79	7.12	31.79	60.21
Royalties	0.00	109.47	0.00	0.00
Tools	5.93	0	4.33	4.33
Wages	715.00	0.00	0.00	0.00
Transport	639.83	1982.00	0.00	0.00
Loading/unloading	140.26	166.15	0.00	0.00
Transport Link	0.00	200	0.00	0.00
Association	0.00	200	0.00	0.00
Rents	0.00	0	133.59	226.87
Wood	0.00	1781.00	5264.36	5552.57
Total	1532.81	4506.44	5434.07	5843.98

Sources SIBI (Feb. 2004)

Table 2.9 shows the structure of the fuelwood market. The revenue per m^3 of fuelwood is allocated as: Producer D248; wholesaler D758; Retailer (KMC) D119; and, Retailer (Banjul) D291. Most of the benefit accrues to the wholesaler. Thus the supply of firewood is regulated through the pricing mechanism and the permit system.

Table 2.10: Evaluation of Fuelwood Balance Situation in 000' Tonnes/year

Description	**1983**	**1993**	**2003**	**2004**
Standing stock	16620	11049.5	7652.2	7312.47
Annual yield	302.0	272.0	153.0	143.48
Consumption	430.0	485.1	648.1	884.55
Deficit	128.0	213.1	495.1	741.07
Population	687.8	1026.8	1360.0	1397.6

Sources: Estimation in the RPTES 1994 adjusted for 2003 population figures and DMCI consumption survey.

Fuelwood supply/demand balance**: Table 2.10** presents the supply/demand balance of the country as at 2004. The supply/demand deficit of 741,070 tonnes in 2004 represents about 83.8% of the national consumption, which is slightly above the anecdotal estimate of 60 – 80 % range of Gambian fuelwood arising from imports. This estimated deficit includes charcoal which tends to be over-sighted in anecdotal estimates of fuelwood imports.

Fiscal Aspects: There are two types of levies-

i. Licence Fees; and
ii. Royalties.

Table 2.11 presents the actual number of licences issued during the 1993/1994 fiscal year as part of the overall control measure exercised by the forestry department to regulate fuelwood supply and trade.

Table2.11: Number of Licences Issued During the 1993/1994 Fiscal Year

Division	FUELWOOD			
	Producer		Community Production	Vendor
	Requested	granted		
WD	40	23	2	9
LRD	40	40	5	15
NBD	40	25	N	N
CRD	40	13	N	N
URD	6	6	3	N

Source: Gambia Forestry Revenues and Budgetory Requirements June 1994
N= Not applicable in the division

In the formal commercial sector, the Forestry Department is responsible for the management of forestry resources. Operators are required by the Forestry Act and the regulations of 1997/98 to obtain non-transferable Extraction Licence that requires the holder to pay D600.00 and each of his three assistances to pay D280.00 each. The licence holder is only permitted to harvest dead trees. The wholesalers pay D500.00 for their licence and D200 per each truckload. A total of 84 people per division are allowed to participate in commercial extraction.

These taxes are determined by the Directorate of Forestry on an annual basis. The monitoring of the huge fuelwood trade across the national boundaries involves the Customs and Exercise Department and The Gambia Police Force.

Petroleum and Petroleum Products:

Petroleum is inflammable, viscous, has a low density and low biodegradability. It is usually handled in bulk. Petroleum thus has the propensity to cause damage to life on land and sea and on the eco-system. Petroleum is also a source of great wealth. Petroleum activities therefore attract international attention and are generally highly regulated.

Upstream**:** Although a non-oil producing nation, The Gambia has legislation, the Petroleum Act (2004), on the upstream petroleum sector. The objective of the Act is to ensure the efficient administration and management of the country's hydrocarbon resources for the maximum benefit of The Gambia people.

Downstream**:** All petroleum products consumed in The Gambia are imported. Unlike the upstream, the downstream lacks a coherent legislation. However, because petroleum products are internationally traded, the oil companies apply similar regulations as obtained elsewhere. Government's interest is revenue bias and DOSFEA and the Customs Department play major roles in this aspect

Institutional Structure of the Energy Portfolio**:** The energy portfolio is currently with the Office of The President and consists of two main technical constituents:-

i. Energy Division with responsibility for the overall energy matters including renewable energy and electricity; and,

ii. Commission on Petroleum Exploration and Production.

The Energy Division headed by the Director of Energy is responsible for the coordination of and formulation of policies and strategies for the overall energy sector. It supervises the activities of The Gambia Renewable Energy Centre (GREC) and cooperates with the private energy companies in harmonizing the functions of the two main groups of stakeholders, the public and private sectors.

The Commission on Petroleum Exploration and Production is headed by a Commissioner. The Commission has a data centre where petroleum exploration and other relevant data are stored. The mandate of the commission includes the promotion of the country's hydrocarbon acreage and the efficient management of the hydrocarbon resource for the benefit of the country. The Commission leans on the Geological Department for technical geological and geophysical expertise.

The Gambia National Petroleum Company (GNPC) is a recent entrant into the petroleum scene. The company is mandated to participate in the upstream sector of the petroleum industry on the same terms as any oil company.

Shell, Elf/Total, Castle and recently Elton are the petroleum products importing companies including kerosene and LPG until recently when they pulled out of that import market. Kerosene (jet/aviation fuel) is mainly used for lighting. Attempts to promote improved kerosene oven for cooking resulted in only marginal market penetration.

LPG is used for cooking and heating. It is imported from Senegal and transported by land. The oil companies have withdrawn leaving the gas companies and the informal sector operators in the market. These companies are: Gam Gas, M & C Gas and Touba Gas. Lack of adequate infrastructure resulting in small parcels of imports has led to the slow pace of market penetration. An EDF funded project (Butane Gas Project) to promote the use of LPG as an alternative to firewood during the first half of the 1990s has had very limited results. **Table 2.12** presents the quantities of LPG imported between 1996 and 2000

Table 2.12: LPG Imports between 1996 and 2000 in Quantity and Value Terms

YEAR	QUANTITY (Tons)	Value (D'000)	Unit Price D/Kg
1996	1450	6827	4.71
1997	1124	5300	3.40
1998	1430	4733	4.72
1999	1380	6130	4.71
2000	1500	7356	4.91

Source: National Energy Policy,2004.

Imports of LPG are sourced from Senegal in small parcels. This contributes to the high prices the consumers have to pay. In addition there are no bulk storage facilities and given its high flammability, its potential risks associated with LPG are very high. Unfortunately, it is not a highly deregulated market.

Table 2.12 shows that the imports and price of LPG from 1996 to 2000 have been fairly constant, which is a reflection of no growth. In the mid-90s, the Government executed an EU funded butane project in an effort to promote the use of LPG and stem deforestation.

Electricity

The share of electricity in the household energy balance is 0.88%. NAWEC is the national electricity company and is the main source of electricity in the country. There is also substantial generation outside NAWEC using private generators. The law on electricity is geared towards the regulation of the formal electricity production sector. Its objectives and purposes are:

- Effect the transition from public to private control through competition
- Regulation of non-competitive areas
- Establishment of cost effective and reliable power supply

The Act spells out the roles of the different actors. The Department of state responsible for energy is charged with overall policy development, promotion of energy efficiency and encouragement of private participation in the sector.

Renewable Energy

The biomass component of renewable energy contributes about 0.51% (biomass) to the household energy balance. The other components of the resources are wind, solar and biomass. There is no wind energy production of an appreciable quantity in The Gambia.

Wind strengths are moderate along the coast and weak in the interior. The assessment of the wind potentials will be part of a study funded by the ADB and executed by the Energy Division of the Office of The President.

Solar energy is harnessed to operate small energy units generally in those areas not covered by NAWEC, in telecommunication, water pumping and heating and refrigeration. Initial capital cost has made its entry into the market difficult. Already some solar companies operate in the country and these include: Gam-Solar, VM Gambia Ltd, Daba Malick Energy Centre, SWEGAM and Sanfos.

Biomass is a renewable energy. Its sources are agricultural residues:- groundnut shells, rice husk, maize, millet, straw and saw dust. These residues can be used in briquetting or to produce biogas. Apart from saw dust, briquetting and biogas may come into competition for raw materials from the livestock sector. It is estimated that about 30,000 tons of briquettes can be produced from biomass. Briquetting, biogas and animal feed are derivates of biomass and therefore compete for raw material

Renewable energy research, development and promotion are under the purview of GREC. The institution was set up to promote and adapt renewable energy technologies and advise Government on renewable energy matters.

2.2.2: Forestry Control Effectiveness

The contribution of 1,500m^3 and 2,200m^3 of logs from natural forests and plantations annually contributes to minimize the demand pressure on the natural forest. Imports of wood is rising probably due to controls in place on local wood supply

Section 2.1 outlined the Gambia Forest Management Concept and the new Forest Policy. The devolution of the management of forest matters to the local level, the involvement of individuals and local communities to take greater responsibilities of the forest resources and their management. Public education on the importance of the forest is aimed to change attitudes to show greater responsibility towards forest resources. The licensing system should also contribute to the reduction of indiscriminate harvesting of the forest produce. These are measures geared to conserve the forest and ensure its sustainable management.

Table2.13 summarizes the achievements under the various forest management strategies. Out of a total forest cover of 448,800 hectares, 52,449 hectares or 12% is under some form of management and 88% of the total forest cover is under no management or protection. The policy objective of 1995-2005 is to bring 75% of the forest land under management. With only one year to the target year, there is still a 63% gap and this is not likely to be closed within the remaining one year. Apart from Western Division that has registered 100 hectares of private forest plantation, there are no plantations in all the other administrative regions. From the statistics in **Table 2.13**, there are some serious reservations about the success of the New Forest Policy 1995-2005.

Thus in spite of achievements of 1500m^3 and 2,200m^3 annual harvest of logs from natural forests and plantations respectively, the rising trend in the import of wood and the statistics in the **Table2.10** appear to negate the effectiveness of the forestry control mechanism.

2.2.3: Decentralisation Process

The Local Government Act, 2002 is the culmination of the deepening of the democratisation process, which aims at the empowerment of the people at the grass roots level. It is believed that by making the people more responsible of their own affairs including natural resources

Table 2.13: Forest under Controlled Management

Division	Forested land area(ha)	Controlled management (ha)						No management/protect (ha)			
		Forest Park	CCSIS & co. Ms	Comm. forests	Private forests	Total		Forest Parks	Forest Reserves	Total	
						Ha	%			Ha	%
WD	73,300	3355	506	6983	100	10944	15	512	62350	62356	85
LRD	66500	1758	448	4567	0	6773	10	4431	55744	59727	90
CRD	154600	7233	6546	9453	0	30130	19	10412	120499	124479	81
URD	113200	858	873	2685	0	4431	4	2178	107464	108769	96
NBD	41200	0	0	230	0	230	1	3290	37680	40970	99
Gambia	448800	13204	0	17387	100	52449	12	12564	383787	396301	88

Source: Sillah (2004)

management, this will accelerate the development process and poverty reduction. It is in this respect that a process of devolution of power from central government to the local councils was initiated in 1993 that culminated into the Local Government Act 2000. The Act makes provision for the Councils to manage their resources.

Section 73(1) empowers "the Secretary of State" to designate as forest parks any council land or any other land in respect of which it appears to the Council that forest growth should be protected, preserved or established.

The Act gives the SOS power to designate land in line with the provisions of the Forest Act, 1997 to be Council forest under the Forest Act. There the Council shall establish Department for the administration of the forest and the transfer of Central Government staff and personnel for the management of the forest.

The Act has provision for the setting up of a Local Natural Resources Committees which shall consist of a chairperson, officers of the Council in-charge of environmental matters, forestry, wildlife and fisheries, two to represent women groups, two to represent groups involved in the management and development of environmental matter, forestry, wildlife and fisheries and other members as the Council may demand it.

2.3 Base Line Scenario for the Development of Energy Demand and Supply.

The energy sector of The Gambia is everything but regulated and coordinated. This laissez faire state of the industry is largely a reflection of the low institutional development and capacity of the sector. One of the major consequences of this poor and inadequate institutional arrangement of the sector is the paucity of and inconsistency in the policy planning information and data set.

It is against the foregoing background that **Table 2.14** has been constructed to depict the base line scenario of the national energy balance sheet as a basis for the development of energy demand and supply. The table depicts the state of energy demand and supply by energy type and overall balance to underscore precarious nature of the energy situation as at 2004

Table 2.14: Energy Demand/Supply Balance Sheet as at 2004 in 000' TOE

Description	Fuelwood			Pet & Petroleum Products			Electricity	Renewable			TOTAL
	Firewood	Charcoal	Total	Petroleum	LPG	Total	NAWEC	PV system	Biomass	Total	
Demand/ consumption	500..50	11.03	511.53	84.73	2.09	86.82	9.64	0.23	2.03	2.26	610.25
Supply/ import	163..90[x]	1..34[xx]	165.24	84.73	1.59[xx]	86.32	14.02	0.23	44.47[xxx]	44.70	310.28
Balance	(336..60)	(9.69)	(346.29)	0.00	(0.5)	(0.5)	4.38	0.00	42.44	42.44	(348.04)

Key: x = Recorded trade flow; xx = Recorded import flow; xxx = estimated available biomass for energy production.
Source: DMCI Consumption Survey

2.3.1 Estimated National Energy Demand at 2004.

Based on the results of the energy consumption survey and data from the Energy Division, **Table 2.14** presents a detailed analysis of energy consumption as at 2004 by energy type. The national energy consumption, as the most appropriate indicator of energy demand, stands at 610,250 TOE comprising 84% fuelwood, 14% petroleum products, 1.6% electricity and 0.4% renewable energy.

Out of a total fuelwood contribution of 84% to the national energy consumption about 82% is supplied by firewood and 2% is provided by charcoal. Also of the 14% contribution of petroleum products about 13.8% is provided by petroleum and only 0.2% is provided by LPG. Similarly of the 0.4% contribution of renewable energy only 0.04% is provided by solar PV system and 0.33% is provided by biomass.

2.3.2 Estimated National Energy Supply at 2004

The estimated total national energy supply as at 2004 is placed at 310,280 TOE. This total national energy supply comprises about 53% fuelwood, 28% petroleum products, 4.5% electricity and 14.3% renewable energy.

Of the total 53% fuelwood share in the estimated supply, 52.6% is made up of firewood and 0.4% is made up of charcoal and of the 28% total petroleum share, 27.2% derived from petroleum and only 0.5 derived from LPG. Of the total biomass share of 14.3% only 0.07% derived from solar PV system and 14% derived from biomass.

The total firewood supply of 163,900 TOE comprises 143,480 TOE estimated annual yield from the forest cover (Table 2.10) and 20,420 TOE of recorded firewood trade flow (Table 2.6) in 2004. The estimated 1,340 TOE of charcoal is derived from recorded import flow of charcoal in 2004. The estimated 44,470 TOE of biomass is derived from estimates of available biomass in Table 1.4. The estimated 1,590 TOE of LPG is composed of imports by local gas companies net of the cross-border trade.

2.3.3 National Energy Demand/Supply Balance at 2004

The foregoing national energy demand and supply estimates as at 2004 depict a deficit of about 348,040 TOE base line scenario representing about 53% of the total national consumption. The individual energy type base line scenario can be summarized as follows:

- **Fuelwood**: the fuelwood base line scenario is a whopping deficit of 394,360 TOE representing about 70% of total fuelwood consumption;

- **Petroleum and Petroleum Products**: the petroleum and petroleum products base line scenario is a negligible deficit of about 0.5 TOE representing about 0.6% of petroleum and petroleum products consumption. Virtually all this deficit arose from LPG. Given that a substantial amount of LPG trade flow is through unrecorded cross-border transactions, driven by the subsidized Senegalese's price, the estimated base line deficit may be a gross understatement of the actual picture.

- **Electricity**: the electricity demand/supply base line scenario is a positive excess supply of about 4,380 TOE representing about 45% of total consumption. Given the widely acclaimed pent up demand for electricity, this excess supply balance is reflective of the huge energy loss in distribution and gross inefficiency due to frequent electricity outage.

- **Renewable Energy**: the renewable energy demand/supply base line scenario is a positive supply balance of about 42,440 TOE representing about 1878%. All this excess renewable energy supply arose from biomass and mainly in a form which traditionally is not readily acceptable for household use.

Overall, the base line scenario for the development of energy demand and supply depicts not only the magnitude of the task but also debouches the precarious state of the household energy situation and its triple dimension. At the present rate of fuelwood consumption the country is seriously eating up its forest capital and therefore precipitating environmental disaster and abject poverty and thus making access to better forms of energy increasingly difficult for the majority of consumers.

3: ELEMENTS OF A HOUSEHOLD ENERGY STRATEGY

3.1: Objectives

The overall energy sector objective articulated in Gambia Incorporated --- Vision 2020 is to overcome the existing bottlenecks in the sector to ensure a reliable and adequate supply of energy, both conventional and renewable, at affordable prices. Pursuance to this overall sector objective, the primary objective of a household energy strategy should be to provide an investment policy framework for maximizing the use of scarce energy resources consistent with maintaining the integrity of the environment especially the forest resource of the country through selecting and prioritising projects and programmes appropriate to the socio-economic and cultural circumstances of the country. In the medium term the specific objectives of such strategy are to:

- Stem the on-going forest resource degradation and its over- arching environmental implications through greater involvement of the population in the rational development, management and utilisation of wood energy resources on a sustainable basis;

- Promote the development, marketing and utilization of the country's alternative and renewable energy resources on a sustainable basis;

- Improve the adequacy, efficiency, reliability, security and affordability of electricity services through the expansion of generating, transmission and distribution capacities;

- Promote expanded adoption of petroleum products especially liquefied petroleum gas (LPG) through the development of reliable and sustainable supply systems and ensuring healthy and safe use within the domestic environment; and,

- Strengthen the institutional capacities to support a copious flow of appropriate end-use household energy technologies through research, development and promotion programmes.

3.2: Expected Results

The realization of the foregoing specific household energy strategy objectives is expected to halt and reverse the prevailing unsustainable fuelwood consumption pattern and associated environmental degradation. To this end, the successful implementation of the strategy is expected to yield a number of important results. Some of the key expected results can be itemized as follows:

- Reduced dependency on and/or sustainable production and utilization of the fuelwood resources of the country;

- Copious supply of fuelwood from established community managed forests and family and private woodlots and plantations managed and utilized on sustainable forest management principles;

- Increased forest cover and improved tree species composition and enhanced biological diversity;

- A wide range of choice of household energy sources to cater for a variety of households of differing socio-economic classes;

- Production of socially and culturally acceptable charcoal briquette from agricultural and industrial biomass waste which serves as an effective substitute for wood charcoal;

- Production and adoption of efficient fuelwood and biomass charcoal briquette end-use appliances which improve the efficiency and reduce the quantities of these household energy sources;

- Existence of a vibrant household energy sector which makes significant social and economic contributions to The Gambian society;

- Existence of adequate and reliable LPG sub-sector which provides accessible alternative household energy to firewood on a sustainable basis;

- Regular, reliable and safe electricity supply accessible to the majority of households;

- Strengthened research, development, extension and regulatory capacities to support a copious flow of fuelwood and biomass charcoal briquette end-use appliances;

- A resilient household energy policy and regulatory environment conducive to the effective participation of stakeholder groups; and,

- Production and use of biofuels of biodiesel and ethanol/methanol as household energy.

3.3: Principles and Strategic Orientations

Given the commonly acknowledged nexus between household energy supply in The Gambia and the progressive deterioration of the environment, the principles and strategic orientations of a well-conceived national household energy strategy must aim at a broad-based population involvement in the effective management of household energy resources in general and of the forest cover in particular for sustained household energy supply. Thus the guiding principles for the implementation of this strategy are:

- The approach of the strategy should be holistic and based on the actual absorptive capacities of the technical agencies and services of the government and populations in terms of techniques, management, finances and economics; and based on popular participation in implementation, monitoring, regulating and enforcement.

- The measures taken should be determined according to the zonal/regional urgencies and acuteness of fuelwood shortage.

- Adaptive and high-yield research oriented activities adapted to local conditions and technical packages that take into account the limited socio-economic potential of households.

- Demand reduction measures through promotion of more efficient use of wood and of alternative energy sources by increasing prices/taxes on forest products, which currently understate the real value of wood.

- Conducive political and economic environment to encourage producers to adapt and intensify their production methods and thus protect the forest cover from abuse such as excessive clearing and shortening of fallow periods, overgrazing, over-browsing, excessive cutting, uncontrolled bushfires, etc. support to fight against the erosion/deterioration/desertification process by means of easily applied, elementary anti-erosive measures.

Consistent with the foregoing guiding principles the strategic focus of immediate-term actions in the household energy sector appears to be the introduction of fuelwood substitutes, renewable energies and cheap electricity especially in the rural areas. Thus a balanced strategic orientation of this strategy will include:

- Forest protection and conservation measures;

- Promotion of Renewable Energy Sources;

- Strengthening of Research, Development, Extension and Regulatory capacities;

- Acceleration of Rural Electrification;

- Improved Coordination of Poverty/Energy/Environment Nexus with Senegal and West African Countries.

Forest Conservation and Protection

Fuelwood, comprising firewood and wood charcoal, is the predominant source of household energy for over 99% of households in The Gambia. It is estimated that over 60% of the fuelwood supply in The Gambia originates from outside. Thus whereas forest in The Gambia need to be managed at sustainable levels, allowing for regulated fuelwood extraction, it is feared that most of the environmental damage associated with fuelwood consumption is actually occurring in Southern Senegal where no monitoring or regulations are currently enforced. Perceived against the backdrop of historical experiences of cross-border trade between the two countries, fuelwood supply in The Gambia can best be described as precarious. This situation is made all the more urgent by the fact that the Germany GTZ forest management activities in The Gambia are about to be terminated, leaving behind a vacuum that will be a matter of great concern to the household energy sector in particular and sustainable environmental management generally. Developing renewable and alternative fuelwood substitutes that will compete with and/or replace firewood and wood charcoal in terms of price, performance and acceptability must be seen as an immediate-term household energy strategy preoccupation. Such a strategic orientation must focus on the following actions:

- Nationwide participatory forest management through rapid expansion of Community Forest Management Concept (CFMC):

- Rural reafforestation programme (including sylvo-pasoralism and farm forestry) focusing on individual and family woodlots/plantations;
- Setting up a dense network of local Government administrative tree museries to serve as a basis for family or community museries;
- The recruitment of guards/extension agents designated and/or paid by the communities in the case of community plantings; and
- Revegetation of common grazing lands and manginal or depleted lands through the implementation of elementary anti-erosion measures.

- Training to support the participatory forest management activities

- Legal reform: review of firewood licensing and the ban on charcoal.

- Research, Development and Marketing of fuelwood substitutes:

- Set up charcoal briquetting factory as recommended by the biomass charcoal briquetting feasibility study;
- Development and promotion of kerosene stoves;
- Encourage and support the private sector companies in the LPG market through the follow-up LPG promotion programme to the eighties EC initiative, realization of the development and adoption of national safety standards for LPG trade in The Gambia to attract new entrants;
- LPG landing and storage facility and LPG distribution system via barges along the River Gambia to expand coverage nationwide; and
- Implement the production promotion of biofuels such as ethanol/methanol and biodiesel.

Promotion of Renewable Energy Sources

All commercial fuels in The Gambia are imported. Given the vast indigenous renewable energy resource potentials of the country; exploitation of these need to be seriously considered for wider scale application than exists now. Such indigenous renewable energy potential could include forest and woodlands where these are managed sustainably so that timber and fuelwood are extracted at levels that can be regenerated. Similarly, agriculture and agro-industrial biomass residues used as source of household energy may be considered renewable.

However to conform to the traditional Gambian energy classification, renewable energy here is limited to biomass wind and solar energy sources. The use of wind as source of energy is mainly in irrigated agriculture whereas the use of solar as domestic energy is limited by its initial capital cost of installation. Thus efforts to promote expanded use of solar energy source for domestic purposes will focus on cost reduction and will include:

- Financing scheme for solar home systems with payback periods of monthly instalments which do not exceed monthly expenditure on traditional options to be replaced such as kerosene, candle, charged car batteries, dry cell batteries, etc;

- Implementation of incentive scheme such as tax/duty exemption for importing companies;

- Design and implementation of a sustained promotion campaign for solar water heaters, solar house systems and PV for domestic application; and,

- Expansion of PV powered drinking water supplies systems for villages and small communities outside GBA commenced under EDF 9.

Strengthening Research, Development, Extension and Regulatory capacities.

The major institutions involve in research and development and extension activities in the household energy sector are The Gambian Renewable Energy Centre (GREC), Appropriate Technology Unit of the Department of Community Development and National Agricultural Research Institute (NARI). The major regulatory agencies are the Department of Forestry, The Gambia Police Force and the Department of Customs & Exercise.

With the exception of The Gambia Police Force and the Department of Customs and Exercise, all these institutions woefully lack human, infrastructural/physical and financial research capacities to effectively discharge their mandates. Thus the strategic orientation to remedy these capacity constraints to enable effective development and utilization of the country’s alternative and renewable energy sources will include:

- Strengthening the human resource capacity of GREC, ATU/DCD and NARI in terms of quantity and quality to conduct meaningful adaptive research into appropriate end-use wood-saving appliances, solar water heaters and cookers wind driven domestic water pumping, biogas and gasification of organic residues;

- Strengthening the physical/infrastructural capacity of these institutions including research equipment, computers and vehicles;

- Improved financial resources through increased budgetary allocations for the efficient utilization and operation of available equipment;

- Strengthening and/or developing outreach programmes to train extension workers and provide technical training of local technicians and artisans in the production and maintenance of renewable energy technologies;

- Develop and implement a countrywide promotional campaign to accelerate the adoption of proven end-use technological packages and appliances; and,

- Strengthening the human and physical capacities of the regulatory agencies especially the Department of Forestry to effective monitor and police contravention of legal provisions.

Acceleration of Rural Electrification

The successful realization of the on-going electrification of 46 towns/villages will have major improvement effect on the household energy situation. This first step in a massive rural electrification drive will need to be cognisance of the deepening rural poverty situation. Thus issue of affordable electric power for both productive as well as more consumption use as source of household energy will be a key strategic orientation.

Given the current high electricity generation cost in The Gambia and the global experience that rural electrification is nowhere considered a profit making endeavour, a household energy strategy should be towards two key issues. These are:

- Consideration of the economics of scale of larger power generation or a shift to alternative low-cost technology options for power generation, transmission and distribution; and,

- A financing and/or subsidy mechanism to create a Rural Electrification Fund to be used for the expansion of the grid into rural areas

Coordination of Energy/Poverty/Environmental Nexus

Most of the energy/poverty issues of The Gambia are not country specific. Some of the key issues such as LPG trade, forest degradation in Casamance through fuelwood consumption in The Gambia, Hydro Power Development in the upper reaches of The Gambia River are inextricably linked with Senegal. These issues should be addressed in a more regional approach. Such an approach is better achieved through coordination and collaboration in such regional initiatives as:

- The sub-regional project of the organisation for the Development of The Gambia River Basin (OMVG);

- The CILSS Regional Programme in the promotion of Domestic and Alternative Energy in the Sahel (PREDAS);

- The West African Power Pool (WAPP) initiated by ECOWAS Energy Ministers; and,

- The West African Gas Pipeline (WAGP) also initiated by ECOWAS Energy Ministers.

3.4 Institutional Set-up

Although it is conceptually possible to conceive of an institutional set-up for household energy, it is practically impossible to perceive of such an institutional set-up as discrete and totally independent of the national institutional framework for the development and management of the energy resources. This framework comprises the following key public and private sector agencies:

- The Office of the President housing the Department of Energy with its technical arm, The Gambia Renewable Energy Centre (GREC) and the office of the Commissioner of Petroleum;

- Department of State for Fisheries, Natural Resources and the Environment (DOSFNRE) operating through its technical arms of the Department of Forestry and Water Resources;

- Department of State for Local Government and Lands operating through the Department of Community Development, Office of the Commissioners and the Area Councils;

- Department of State for Finance and Economic Affairs operating through the Department of Customs and Exercise; and,

- Private Companies/Energy Companies including the oil companies and renewable energy technology companies

The institutional set-up of the household energy sub-sector includes an aspect of all elements of the foregoing institutional framework and in addition includes:

- Department of State for Interior and Religious Affairs acting through The Gambia Police Force; and,

- The Non-Governmental Organisation (NGO) community

Thus the institutional framework for the development and management of the national energy sector is fragmented along sectoral lines ie fuelwood, petroleum, electricity and renewable sectors and so is its subset household energy resources. This institutional framework will be strengthened and capacitated, and by extension the institutional set-up for the household energy subset, through appropriate institutional reforms and rationalizations. Such institutional reforms and rationalization will include:

- The creation of a department of state for Energy with clearly articulated "pro-poor" policies in the energy sector to increase access to affordable energy services for the poor in The Gambia;

- Privatisation of National Water and Electricity Company (NAWEC);

- Establishment of an Energy Regulatory Board to support the new Energy State Department;

- Biomass Charcoal Briquetting Factory jointly funded by the Gambia Groundnut Corporation (GGC) and Federation of Agricultural Cooperative Societies (FACS);and,

- Establishment of a Rural Electrification Fund or Renewable Energy Fund.

3.5: Regulatory Improvements

Like the policy planning and implementation, regulation of activities in the energy sector in The Gambia is fragmented along sub-sectoral axis. Currently, regulatory functions in the electricity sub-sector are carried out by the Department of Energy in the President's Office. Petroleum exploration is regulated by the Office of the Commissioner of Petroleum in the Office of the President. However, the petroleum products market is unregulated with the only regulatory measures being price formulation for market stabilization and the regulatory oversight of the two major oil companies relying on goodwill. The fuelwood sub-sector is the most effectively regulated energy sub-sector and the renewable energy sub-sector is the least regulated due to its novelty and relative size in the national energy equation.

In the light of the rather inadequate overall energy sector regulatory framework, the draft National Energy Policy recommended a number of regulatory-related measures, which will improve the performance and conduct of the household energy sub-set. These regulatory improvements are:

- The enactment of a Gambia Electricity Law- which will empower the already established Authority;

- The enactment of Energy Law

- The enactment of Public Utility Regulatory Bill which has established a Utility Regulatory Authority to handle regulatory matters in the energy sector;

- Institution of minimum safety and quality standards and issuance of licences for the various activities in the import/supply/resale chain of petroleum products such as for transportation, storage, and wholesaling/retailing and distribution operations;

- Establishment of a Small National Laboratory to regulate quality control of petroleum products; and,

- Legislation binding safe storage, transportation and use of LPG for environmental and safety standards.

3.6: Fiscal Intervention

Compared to their potential substitutes of petroleum products and renewable energy sources, fuelwood energy sources of firewood and wood charcoal are the cheapest source of household energy. Given the deepening widespread poverty, the primacy of fuelwood as household energy source is not likely to be abated in the near future without calculated fiscal measures to make alternative sources competitive.

While petroleum duty and sales tax revenue constitutes a significant source of public financing, petroleum products occupy an important position in the national energy balance. Thus fiscal incentives to make petroleum products competitive will have to be selective and well designed. At the sub-sector level, such fiscal incentive considerations must start with a review and analysis of the cost elements in the petroleum pricing formula with a view to bringing down the costs of petroleum products generally. Other general petroleum sub-sector fiscal measures should include:

- Ensuring that all required fiscal metering is performed in accordance with the regulations;

- Ensuring that petroleum pricing mechanism functions in accordance with regulations to result in open competition; and,

- Ensuring that the tax system functions in accordance with existing regulations.

Other specific incentives measures should focus on the special case of LPG given its fuelwood substitution potential and paucity of facilities for its safe handling and distribution. It would be necessary to waive all import duty and sales tax on LPG for sometime and grant a duty free concession on the importation of all equipment associated with storage and distribution of LPG.

At the level of renewable energy promotion, fiscal interventions will be required at two levels: the briquetting plant and importation of renewable energy devices. These fiscal interventions should include:

- Allowing for 100% depreciation of the briquetting plant;

- Subsidy to encourage setting up of the venture;

- Making possible availability of low interest loan for the capital cost of the plant;

- Exemption from duty and sales tax for the enterprise on all imported items; and,

- Exemption of duty and sales tax on all imported renewable energy devices.

3.7: Demand-Side Management Interventions

The key demand-side management issues have been amply highlighted in section 3.3 above to need extensive discussion here. It would however, be necessary to emphasise that the successful implementation of such demand-side interventions will critically depend on the unflinching participation of the public, communities and the private sector with clear recognition of each others' comparative advantage. Two other important demand side interventions of general development nature are the issues of population pressure and overall economic prosperity. These issues will require intensified and sustained actions at two levels:

- Reducing the population pressure through intensified and sustained population management activities to bring down the 2.77% population growth rate; and,

- Poverty reduction through intensified and sustained income generating activities

While awareness and adoption of improved energy saving end-use technology and appliances will be partly a function of concerted public promotional campaign, energy substitution will largely be influenced by economic growth and rising income of consumers. Temporary measures such as subsidies on energy sources and appliance may be important at their introductory stages, they are not sustainable in a highly restrictive public revenue-base economy like The Gambia.

3.8: Supply-Side Management Interventions

Like the demand-side management interventions, the key supply-side measures have been well articulated in section 3.3. However, two important aspects of supply-side issues need under- scoring. These are community forestry and commercial fuelwood trade.

3.8.1: Village-based Participation Management of Forest Resources

In response to the accelerated degradation of the forest cover which commenced in the early 50s, the government adopted a number of natural forest management models. These had very limited success. The models were exclusive and focussed on bushfire prevention and stand forest management. The failures of the exclusive approaches necessitated revisiting the policy, legal and institutional instruments to properly align them and make them more responsive to the new inclusive participatory approach.

The overall strategy is to promote natural forest management in accordance with The Gambia Forest Management Concept (GFMC). This consists of the following sub-strategies:-

- Community Forest Management (CFM)

- Community Controlled State Forest Management (CCSF)

- Joint Forest Park Management (JFPM)

Community Participation

The current forest management strategy is participatory. It recognises the pivotal role of the involvement of the local communities to ensure the attainment of the objective of sustainable supply of household fuelwood which constitutes more than 97% of its energy balance. The communities participate in forestry management through the following strategies:-

Community Forest Management (CFM)

CFM is executed in three phases – start-up, preliminary and implementation phases. The process involves awareness creation, land identification, election of committee, contractual agreement, demarcation, training, the community provides the labour. The community collects firewood including tree branches and retain any revenue etc.

Community Controlled State Forest (CCSF)

This form of community participation in forestry management involves cooperation between the CFM and the FD where they cooperate to manage state forest, that is, other forest areas outside forest park and community forest, that is, the "open access forest". The bulk of commercial fuelwood comes from the "open access forest". No community has opted for this arrangement probably because of the 50/50 benefit share ratio principle.

Joint Forest Park Management (JFPM)

This form of community involvement in forest management has taken more prominence in the CRD, which has a total of 24 parks. Two are planned in the LRD. Altogether there are 1800 ha of JFP in The Gambia.

Prospect for community participation are greater in CRD because it has huge forest. WD has reached its peak. URD has a bleak prospects due to the land tenure system and NBD lacks forest cover.

A brief review of the experience with implementation of the foregoing strategies revealed that community forest management strategy has the greatest impact. The least successful is the community controlled state forest management strategy. Its non-adoption is probably due to its 50/50 revenue sharing structure which may be deemed disadvantageous. Joint forest park management has limited success.

Western Division has reached its peak. It is the region with the highest population density apart from Banjul and Kanifing. It is also the only region with private forest plantations.

Upper River Division is not responsive to community participation in forest management because of traditional bottlenecks. North Bank Division has no forest. Central River Division has forest and has the greatest potentials.

Thus the emphasis of the household energy strategy will among others be addressing the problems of URD, study the possibilities of community forest in the least densely populated region of the country. The CRD and LRD may offer the greatest potentials to convert more land into forest land.

Although there is considerable awareness in the importance of forests, there is scope to deepen the knowledge including the need to create forest in a drive to achieve sustainable forest management. Given the limited resources base of the communities, external assistance will be an important determinant in the success of the strategies.

3.8.2 Control of Commercial Fuelwood

Table 1.7 above summarizes the fuelwood situation as at 2004. A close scrutiny of the table reveals the following trends in the fuelwood supply/consumption relationship:

The standing stock, that is, the forest cover and the yield, that is, resource and supply, are both fastly depleting. At the same time, both the population and consumption are growing fast and the consequence is a huge and growing demand deficit. The picture that the table depicts is consistent with all the other previous studies such as the Openshaw's and ORGATEC's studies.

The Gambia's population density changed from 64 to 97 to 128 persons per square kilometre in 1983, and 1993 and 2003. As population increases, settlements expand into agricultural land which compensated by clearing more forest land thereby eroding the supply base for fuelwood. In 1980, the area under cultivation was 274100 hectares. This increased to 336000 hectares in 1985. The expansion that is assumed to have been made into the savannah area could have recreated 765,000 tons of commercial wood.

In the face of this imminent threat to the supply of fuelwood a number of policy options are possible: population growth control, improvements in agricultural efficiency and appropriate forestry resources management.

A number of forestry management initiatives have been tried and are being tried. These initiatives include both supply- and demand-side management interventions.

Demand-side management initiatives include development of improved woodstoves for efficient utilisation of fuelwood, fuel substitutes such as butane gas, solar, biomass, electricity etc.

The supply-side management interventions include promoting private plantations, village woodlots, national tree planting, forest parks, community forest. Regulatory mechanism is also put in place to address harvesting and commercialisation through licensing and royalties on fuelwood.

A number of actors are involved in the fuelwood market. They include the producers, market vendors, retailers, roadside producer/ vendors/retailers and transporters. The producer is permitted to have not more than three assistants and each should pay D250. the producers licence is not transferable and is not allowed to hold a vendor's licence at the same time. He is allowed to harvest only dead trees within the issued division. He is prohibited to collect from village land with community licence and managed forests. The number of truck loads per period is also regulated. The producer's licence also specifies the types of took that can be employed.

Charges are levied on the removal of forest produce including fuelwood. There is also a transportation charge and this varies according to the tonnage/ type of the carrier. Fuelwood vendors are required to pay fees.

The beauty of the control mechanism is its flexibility. The law/ policy makers have left it open to the Forestry Department to determine the levels on an annual basis. The mechanism can be applied restrictively or liberally to decrease or increase supply depending on the set goals.

Other institutions that can help in the control of commercial fuelwood are the police, customs and local councils. The police and customs can monitor fuelwood movement at the various checkpoints to ensure that these are permissible movements. The local councils, in collaboration with the Forestry Department, may levy fees on the market vendors/ retailers that are in resonance with the Department's assessment of the ability of the resource base to sustain a particular level of supply.

3.9 Financial assistance mechanisms at the village, community level

Basically, the participating communities in the participatory forest management scheme finance their activities through their own village funds in their VISACAs or with their VDC committees. However, The Gambia Government through the National Forest Fund, the NEA Capacity 21, CILSS forest park competition, the German Government either through the projects or the Embassy fund, FAO and some NGOs have assisted either in the initial stages or in the consolidation phases of the programmes. Recently, FACE and Youth Corps both under the UNDP have taken up capacity building of some communities under the scheme. These mechanisms of financial assistance at village community level will need to be consolidated and appropriately focused on the need to expand community involvement in forest management.

3.10 Technical and Financial Assistance to Private Operators

The key constraints to expand supply and adoption of alternative and renewable energy resources and technologies have been the limited technical and financial capacities at all levels of the household energy sector. The successful implementation of this strategy will by its broad-based participatory nature, require substantial technical and financial assistance for all groups of actors especially the private sector operators.

Provision of technical and financial assistance in five areas of private interventions in the household energy demand/supply equation will be critical to the realization of the objectives of this strategy. These are:

- Establishment of Private Woodlots and Plantations;
- Establishment of a Briquetting Plant;
- Construction of LPG Jetty and Storage Facilities;
- Local production of Fuelwood End-use appliances by Blacksmiths; and,
- Creating Private Sector Solar Cooker Maintenance and Repair Capacities.

3.10.1: Establishment of Private Woodlots and Plantations

Given that about 60% of the country's fuelwood supply originates from outside and given the alarming rate of degradation of the national forest cover, the need to expand the fuelwood supply base of the country is thus a key strategic issue in the medium to long-term. To make a meaningful impact, this would require the establishment of about 1200 hectares of woodlots and plantations of private and family ownership.

It is estimated that the establishment of 1ha Gmalina woodlot will cost about D41,550.00 including the recurrent cost of tending for the first five-year period of establishment. The trees will start producing firewood by end of this period. Thus to establish a surface area of 1200ha of family and private individual woodlots and plantations (600 x 1 ha family woodlots and 120 x 5 ha individual private plantations) will require a total capital outlay of about D50 million net of technical support by the Forestry Department.

3.10.2: Establishment of Briquetting Plant

The establishment of a briquetting plant to produce charcoal briquettes will be a crucial element of this strategy to provide an acceptable substitute for wood charcoal whose destructive nature in the household energy dilemma is a widely acknowledged phenomenon. The sectoral study on the feasibility of producing charcoal briquettes from the vast biomass resources shows the endeavour to be financially a viable proposition.

In view of the difficult financial predicament of the GGC and FACS, the realization of this strategy element will require substantial financial assistance. It is estimated that a total of D4.5 million would be required to meet the capital investment cost of the plant.

3.10.3: Construction of LPG Jetty and Storage Facilities

In the medium-term the most viable substitute for fuelwood is LPG gas. Both the demand and supply of LPG are mainly constrained by cost and small parcels of import. The construction of a jetty and storage facilities will make the import of large volumes possible which would ensure ready availability and accessibility at a cost comparable to those prevailing in neighbouring Senegal.

Moukhtara Holding Company Ltd is one potential private enterprise which has shown lot of interest in venturing into the construction of LPG jetty and storage facilities. Tentative estimates of this venture are placed at about US$7 million equivalent to about D210 million. Whatever the ultimate form of ownership, the realization of this venture will require substantial technical and financial assistance of the magnitude of these tentative estimates.

3.10.4: Local Production of Fuelwood End-use Appliances by Blacksmiths

A key demand side invention to reduce the quantity of fuelwood demanded and consumed will be the widespread use of efficient fuelwood end-use appliances. There is a good array of such well known appliances. These have been developed locally but their widespread adoption is constrained by their costs as perceived by over 60% of rural households.

Currently these appliances are almost exclusively produced in the Greater Banjul Area. Producing them in the provincial growth centres will greatly facilitate their availability with a good potential of making them cheaper. This would require setting up at least 2 Blacksmiths in each of the main growth centres of Basse, Bansang, Kuntaur, Kaur, Soma, Farafenni, Kerewan, and Brikama at an estimated cost of about D50,000/Blacksmith. This works out to a total financial assistance of D800,000.00.

3.10.5: Creating Private Sector Solar Cooker Stove Maintenance and Repair Capacities

The potential use of solar cooker stove for cooking is fairly good given the abundant sunshine throughout the country. The key limiting factor to its rapid adoption is the high cost of acquiring the appliance as observed by 52% of urban households and 42% of rural households. Of equal importance as the capital cost of this appliance is the availability of maintenance and repair facilities.

Thus to stimulate widespread adoption of this appliance would require the availability of easily accessible maintenance and repair services. Therefore an essential element of a package to promote solar cooker stove will be setting up private individual maintenance and repair facility service providers. It is estimated that setting up of about 7 such individual service providers at a cost of about D150,000 each will produce the desired effect. This amounts to a total financial assistance of about D1.05 million.

3.11 Training

Although there is a general lack of capacity in the country, the capacity constraints in the energy sector is particularly acute. There are capacity constraints at individual, institutional and systemic levels of the industry. Of the three levels, capacity constraints at the individual level are most pronounced.

The institutional developments and regulatory improvements suggested above are designed to mitigate the constraints at the institutional and systemic capacity building levels of the household energy sub-sector. However, the overall effect of these measures is unlikely to be maximal in the medium-term without calculated attempts to address some of the restrictive individual capacity bottlenecks in the short-term. Such capacity bottlenecks are more critical at research and development and commercial levels.

3.11.1: Individual Capacity Constraints in Research and Development

There is a dearth of highly qualified researchers in all the household energy- related research institutions including GREC, NARI and the Appropriate Technology Unit of the Department of Community Development (DCD/ATU). It would be necessary to improve the research capacities of these agencies through intensive training of their existing research staff and expanding their staff strengthen to cope with the emerging technological challenges of the household energy sub-sector

3.11.2: Individual Capacity Constraints at the Commercial Level

The critical lack of qualified professionals and technicians at the commercial level of the household energy chain has been a deterrent to the rapid adoption of existing end-use appliances. The lack of artisans especially qualified blacksmith to produce available improved fuelwood stoves at local level has kept their prices above the reaches of most rural households. The setting up of blacksmiths at major growth centres will have to be complemented by intensive induction training of the would-be smiths jointly by GREC, NARI and DCD/ATU and subsequently to be given regular in-service training on an annual basis to keep abreast with technological advances.

The lack of adequate qualified professionals and technicians have made it impossible for the dealers, especially in solar appliances, to provide reliable and sustainable after-sales services programmes. Similarly the lack of private maintenance and repair facilities especially in the provincial growth centres accounts for the limited use of these appliances in the rural areas. Thus a complementary training activity to the creation of a private sector solar cooker stove repair and maintenance service capacity proposed above would be training of professionals and technicians in solar and wind end-use appliances. This would require the development and introduction of a regular training course at GTTI with the collaboration GREC, NARI and DCD/ATU.

3.12 Monitoring and Evaluation

The energy sector consists of a number of sub-sectors and their activities are often uncoordinated. The Office of The President that has overall responsibility for energy matters has at best coordinating function. The sub-sectors that are directly under it are upstream, NAWEC and to some extent renewable energy where its role is limited to promotion. Fuelwood falls under the responsibility of the Forestry Department. The Department of Community Development is involved in the promotion of energy efficient fuel appliances. Thus the effective monitoring and evaluation of the household energy sector would be better achieved through a tripartite sharing of responsibility among the Energy Department, GREC and the Department of Forestry.

The Department of Energy

The mandate of the Energy Department includes monitoring and evaluation functions. However, given the weak institutional strength of the department it has not been able to perform these functions in the past. In view of its central role in the overall national energy sector, it is in a vantage position to assume the functions of monitoring and evaluation of the modern energy sector. For this purpose the department would need to be appropriately and adequately staffed to assume responsibility for the electricity and petroleum products components of the modern energy sector.

The Gambia Renewable Energy Centre (GREC)

GREC is the technical arm of the Department of Energy responsible for renewable energy research, development and promotion. Thus it would be appropriate for the department to entrust it with the responsibility for the monitoring and evaluation of the renewable energy sector. This would require the Centre to be appropriately and adequately staffed and equipped to assume these functions.

The Forestry Department

The Forestry Department is probably the only institution that has a monitoring and an evaluation unit. This unit is expected to facilitate the storage and retrieval of data. The unit was set-up in 2003 and as such is in its teething stages. Thus to assume the functions of monitoring and evaluation of the fuelwood sector, it would be necessary to appropriately staff and equip the unit.

BIBLIOGRAPHY

Bakker, Peerke de (2003): The Gambia Country Side, European Union Energy Initiative for the Eradication of poverty and Sustainable Development (EUI), EU Delagations, Banjul

FAO (1995): Fish Smoking in The Gambia- study on Fuelwood Consumption and Cost and Earnings, Integrated Coastal Fisheries Management in The Gambia Pilot Project of INT/91/007, Rome Italy

Republic of The Gambia (1994): Review of Traditional Energy Sector (RPTES), Country Study 1st Draft, Banjul, The Gambia

Republic of The Gambia (1982): Energy Survey and Master Plan Report- Draft Final Report ,Banjul, The Gambia

The World Bank (1985): Fuelwood and Domestic Energy: The Fuelwood "Crisis" in the Tropical West Africa by Jean Grose, Senior Forestry Specialist and Agronomist, EDI/Energy 111 Seminar 6.7.85, Revised Issue No.2

World Bank (1994): Review of Policies, Strategies and Programme in The Traditional Energy Sector (RPTES). Workshop 11: proceeding s (Working Level Translation from French), Onagadougou, Burkina Faso.

Energy Division/ CILSS (2004): Report of a National Household Energy Consumption Survey in The Gambia by Development Management Consultants International (DMCI) for the 8th EDF Supported

Regional Programme for the Promotion of Household Energies in the Sahel (PREDAS), Banjul, The Gambia.

Republic of The Gambia (2004): National Energy Policy, Sector Overview, Final Draft by Shale Invest Management. International, Banjul, The Gambia.

ANNEX 4.1

Report of the Study on The Feasibility of Producing Charcoal Briquettes In The Gambia

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1 INTRODUTION AND CONTEXT& BACKGROUND

1.1 Introduction

PREDAS is a CILSS regional program on the promotion and development of domestic and alternative energy in the Sahel. With PREDAS assistance, all CILSS countries will work towards developing and validating a Household Energy Strategy (HES).

In most CILSS countries, household energy is synonymous with biomass energy – and will be for quite some time to come. The Gambia is no exception, with 80% of the energy balance derived from biomass. Although some tough policy decisions were taken about 25 years ago, the impact has not been evaluated. Under the supervision of the Technical Working Group and the Energy Division, Office of The President, Development Management Consultants International was engaged to review if charcoal substitutes can be produced legally. The production facility should ideally be privately owned, and if possible privately financed.

Prior to finalizing the HES for the Gambia, four complementary studies will be carried out:

- National energy consumption survey, to describe the types and quantities of energy as well as perception toward the different forms of energy;

- Charcoal sector review, to describe the current process of charcoal production and supply as well as identify barriers to improving the efficiency;

- Charcoal briquetting study to identify the feasibility and the potential of a supply of charcoal briquettes made from carbonised agro-industrial residues, to replace wood charcoal; and,

- Review of the experiences with community-based natural resource management.

This report presents the findings of the study on the feasibility of the production of charcoal briquettes.

1.2 Context & Background:

Charcoal is illegal to produce, yet is one of the main fuels. Given the increases in modern energy prices during the recent times, urban households are considering switching back to charcoal, which is also seen by urban dwellers as a modern fuel. Rather than allow local production or increase (illegal) imports, it might also be possible to produce a charcoal substitute from agro-industrial residues. It appears that 80-90,000 t of groundnut shells are available, which could technically produce 25-30,000 t of charcoal briquettes per year. This already exceeds the total estimated consumption of charcoal for the country estimated at 15,256 tonnes. In addition to groundnut shells, saw dust is available in fairly large quantities also. Although carbonising sawdust is feasible, it might not be simple to achieve, and therefore could be expensive. However, non-carbonised briquetting at elevated temperatures and pelletising would produce a good product from sawdust. In the early 80s, a groundnut shell briquetting plant operated for some time but ceased operating for lack of a market for non-carbonised briquettes.

The main questions therefore are not only technical, but also regulatory, financial, and institutional.

1.2.1 Objectives of the Study:

The primary objective of the current study is to determine the prospects of transforming agro-industrial and agricultural residues into charcoal briquettes. Consistent with this overall objective its specific objectives are:

- Estimate the sustainable supply of agro-industrial and agricultural residues, determine the cost of supply, and identify if alternative uses already exist; this would yield the *technical potential;*

- Review the technical alternatives to produce charcoal from the above residues (simple kilns, retorts, etc), and briquettes from the charcoal (agglomeration, rolling band press, screw press, etc.) using a binder; determine the production costs;

- Carry out a preliminary financial analysis to determine the viability to replace charcoal with charcoal briquettes; different scenarios can be distinguished: the firm with the residues is the investor; a third party investor under a BOO scheme (Build, Own, Operate) or BOOT (Build, Own, Operate, Transfer), or as an energy services company. If charcoal briquettes are equally expensive as charcoal, the potential market is roughly the same size as the charcoal market; if charcoal briquettes can be produced for lower costs, it might substitute for a part of the firewood market. This would yield the financially viable potential; and,

- Determine the legal, fiscal, regulatory incentives that could (should) be given to realize a private production of charcoal briquettes. It will depend on the scale of production, and how serious the Government is to ban charcoal or allow imports of energy sources to take place. This yields the *economically viable potential.*

!.2.2 Review of Briquetting Experience in The Gambia

In a bid to stem down on the rising deforestation due mainly to high demand and use of firewood and wood charcoal and the consequential effects these have on agricultural production and productivity and the environment, the government of The Gambia commissioned several studies in the mid to late seventies to study these unfavourable developments and to recommend a way forward. The recommendations that emanated from these studies culminated in the purchase and installation of a briquetting plant at Gambia Produce Marketing Board (GPMB) decorticating mill at Denton Bridge (later transferred to Kaur). The main objective was to produce briquettes from groundnut shells (agro-industrial waste from the processing of groundnuts). It was intended that this would replace firewood and wood charcoal, particularly in the urban areas, for domestic cooking, heating and ironing thus reducing the demand for the same on the forests.

The Plant

As stated above, the plant was originally installed at Denton Bridge. However, following the modernisation of the Denton Bridge complex in the early eighties with the use of more groundnuts shells in direct combustion in boilers to produce steam for power generation and

process, it was envisaged that there would not be enough excess shells to operate the briquetting plant. It was thus transferred to Kaur.
The plant had an installed capacity of 6 tonnes of shell briquettes per hour. The major plant equipments were: -

1. Nut Extractor
2. Air Pump
3. Rotary Valve with hopper
4. Cyclone c/w pipeline
5. Buffer tank
6. Slide gate
7. Distribution Screw Conveyor
8. Screw Conveyor with hopper
9. Screw doser
10. Briquetting presses (4no)
11. Overflow bin
12. Compression tracks
13. Tracks
14. Belt Conveyor
15. Bagging balance
16. Water dosing system
17. Control Panel

The plant was a turnkey project and cost D. Kr. 2,618,640.00 (GMD918,821.00) in 1978. The plant was not used extensively due to several factors, key amongst these were: -

- ♦ The absence of extensive and intensive marketing strategy to promote the sale and use of briquettes as domestic fuel. Sales were low and the operation of the plant became unviable.

- ♦ Resistance to change! The briquettes were meant to replace wood charcoal and firewood for cooking and heating, especially in the urban areas. At the time the briquette was introduced into the market, there was no legislation banning the use of wood charcoal. The briquettes being new and having unfamiliar initial burning characteristics were thus required to compete with the traditional domestic fuels. This coupled with lack of extensive sensitisation and other factors resulted in the briquettes loosing out in the competition.

- ♦ A survey carried out by Hoff & Overgaard in 1978 found that some households' members complained that the briquettes were smoking a bit more excessively during the starting of the fire as compared to wood charcoal.

- ♦ Most retailers involved in the marketing of charcoal were reluctant to sell briquettes complaining amongst other things low profitability, storage difficulties (briquettes were fragile and break up easily, susceptible to damage by moisture and termites).

Most of the above issues could have been resolved if there were commitments and proper marketing strategies in place highlighting the positive side of the briquettes such as the lower energy cost per unit calorie, the greater heat generated by the briquettes compared to charcoal. The issue of smoke could have been overcome by either a slight change in technology to make the briquettes more compact and smaller in size or ensuring enough ventilation during the initial stages of starting the fire.

Notwithstanding the above constraints, the conclusions of the quoted survey were that:

- The production of groundnut shell briquettes was viable both financially and economically.

- There would be need for legislation to curtail the sale of charcoal. Of course this legislation was later put in place but at the time the legislation came on board, there were no briquettes for sale. The plant had ceased operation on the pretext that it was not viable because of low sales.

Successes

In the context of briquetting experience in The Gambia, it is difficult to pinpoint any success except for the realisation earlier on, of the potentials of using agro-industrial waste for the production of briquettes as alternate source of domestic fuel. The use of agro-industrial waste as a source of fuel in industry in The Gambia had long been recognised and put in practice. The Gambia Produce Marketing Board (GPMB) used groundnut shells to fire boilers (direct combustion) to produce steam for process and electricity generation at its Denton Bridge Factory Complex. This had saved the Board a lot in terms of electricity cost on its operation of the factory.

Economic, Social & Environmental Impact of the Briquetting Plant

The briquetting experience in The Gambia made very little, if any, economic and social impacts on the country. The reason being the limited use made of the briquettes. The briquette project could have helped in the development and use of improved cooking and heating stoves. Both projects should have been conceptualised and implemented simultaneously. It is unfortunate that vast amount of energy in groundnut shells are being wasted by burning openly, which increases air pollution and degradation of the environment. This is made worst when one considers the fact that nutrients within the shells are not returned to the soil resulting in serious soil mining. It was estimated that the briquettes to be produced would replaced about 60% of household domestic fuel needs of the urban areas [Hoff & Overgaard A/S]. This would have reduced the demand on the forests in terms of the cutting down of trees for firewood and the production of charcoal.

If there had been proper strategic plans and vision, the groundnut shells alone could have gone a long way to reducing the import bills on fossil fuels for power generation. During the period when the briquetting plant was installed, groundnut production in the Gambia was very high and GPMB used to handle about 100,000 tonnes annually. This amount of groundnuts was capable of producing about 30,000 tonnes of groundnut shells, which could have generated about 2.7MW of electricity. GPMB's Denton Bridge factory complex electricity demand was in the region of 750KW. Thus GPMB could have supplied to national grid over 1.8MW for about 200 days and over 2.5MW for another 100 days. At that time, this would have constituted over 25% of the Gambia National Utility's (GUC) installed capacity.

The assumption here (achievable of course) is that Denton Bridge would process about 60,000 tonnes within a period of 200 days whilst Kaur would process about 40,000 tonnes. The shells produced at Denton Bridge would have been burnt directly in boilers, without the need for briquetting, to produce the required electrical power. As groundnut shells have low bulk density and therefore costly to transport in their loose form, the shells produced at Kaur could have been briquetted to increase their bulk density and thus reduce the transportation costs. These shell briquettes would then be transported to Denton Bridge using river barges for power generation for 100 days after the Denton Bridge factory completed processing. The entire power generated during this period could have been fed into the national grid. See **Appendix 1.1** for the analysis.

Thus where a failure was experienced in the use of briquettes as a source of low-grade energy for domestic purpose, the same should have been used to produce high-grade energy in the form of electricity. A plant costing close to one million Dalasis by 1978 standard was left idle and could not even recoup a fraction of its costs. A disaster indeed!

II. ESTIMATION OF SUSTAINABLE SUPPLY OF AGRICULTURAL AND AGRO-INDUSTRIAL RESIDUES

2.1. Sources of Supply of Agricultural Residues and Agro-Industrial Wastes

In this section of the study, a brief survey of The Gambia's agricultural activities follows. This is being done with a view to determining the potential availability of agricultural wastes for carbonisation and briquetting. Like in similar studies everywhere, the word available will be used quite wisely to mean the excess after deducting the requirements of growers either as a feed for animals, fencing, etc. An analysis of other competing uses will also be carried out to establish viability for use as briquettes for fuel.

The Gambia has a population of about 1.36m inhabitants according to 2003 national census. The majority of Gambians are involved in agricultural activity of one form or the other. According to the Department of Planning (DOP) in the Department of State for Agriculture (DOSA), agricultural census of 2001/2002, about 304,856 hectares are under cultivation of the major crops. These major crops are groundnut, millet, sorghum, maize and rice. The other crops include cotton, findi, sesame, cassava, watermelon, etc. Because of the relatively low level of production of the last category, except cotton and sesame, these will not be considered further. The study will therefore concentrate on the major crops to quantify the amount of waste production, availability and quality.

2.1.1. Major Determinants of Biomass Production

Agricultural activities in The Gambia are influenced by several factors: -

- **The weather.** The Gambia being in the Sahelian zone of West Africa suffers from erratic and 'unpredictable' weather pattern. There are years with low precipitation and years with relatively good precipitation. These conditions negatively or positively affect agricultural production and productivity for all crops. Rainfall amounts vary between over 1000mm to sometime below 600mm. Whenever there is persistent low precipitation, farmers tend to grow crops with short maturity cycle. The type of crop grown affects the amount of residues produced. As an example, the 90 day cycle groundnut (73/33) produces less fodder (hay) than the 120 day cycle variety (28/206). This therefore makes long term forecasting very difficult.

- **Soil Fertility.** Due to overgrazing (high density of animal population), over cultivation and erosion (deforestation & desertification), soil fertility in The Gambia is low. Except along the banks of the River Gambia where the soil is loamy, the soil is generally sandy with low clay and organic matter content and therefore low water holding capacity. The soil is poor in nutrients and of frail structure. These factors all result in low productivity of crops. Farmers are however well aware of this situation and therefore artificial fertilizer is commonly used to enrich the soil to increase productivity. Availability of artificial fertilizer in sufficient quantities is sometime a problem.

- **Farming Practice.** The level of mechanisation in the Gambia's agricultural activities is very low. Farming is mainly a manual job although the use of animal traction is widespread.

The low level of mechanisation coupled with low soil fertility and unavailability of artificial fertilizer in sufficient quantities result in the low productivity of crops and therefore low production and availability of residues.

2.1.2. Survey of the Main Crops in Relation to Biomass Production

Groundnuts**:** The cultivation of groundnuts is a culture in The Gambia. It is both a food and cash crop. The area under groundnut cultivation is between 45 – 50% of the total land area under cultivation. According to the Department of Planning of DOSA out of a total land area (304,856 hectares under cultivation in 2001/2002), 138,888 hectares (45.5%) was devoted to groundnuts cultivation. The average area under groundnut cultivation over the past ten years is 92,825 hectares with corresponding production of 92,989 tonnes (DOP), **Annex 2.1** It is grown in all the divisions of the country with an average yield per hectare of 1 tonne. This is the national average, which can be increased to between 1.5 to 2.0 tonnes per hectare with the application of the correct fertilizer formula and rate.

The by-product (residue) produced at farm level is groundnut fodder (hay). Estimated yield of fodder is about 1.5 tonnes per hectare (ASPA). The other by-product is groundnut shell but this would be looked at from an agro-industrial waste point of view. Thus, based on 2001/2002 national agricultural census, there is potential to produce over 208,000 tonnes of hay annually. Groundnut hay is a good candidate for carbonisation and briquetting. However, there are other competing uses for it. As a result of its palatability and digestibility, it is used extensively as an animal feed within the farming community. The high animal population density in The Gambia and the lucrative trade in hay within the sub-region, especially Senegal, has made its availability for conversion into biomass energy rather uneconomical as shown in the cost analysis.

Millet**:** Two varieties are grown in The Gambia – early and late varieties. The crop is basically a subsistence food crop although the excess is traded locally and within the sub-region. The average area under cultivation for millet (both early & late) over the past ten years is 76,374 hectares with corresponding production of 78,464 tonnes (DOP). Yields of the early variety in terms of grains are higher than that of the late variety. However, the latter produces more by-product than the former. For the purpose of this study an average will be assumed using a by-product to grain ratio of 2.1 (COWIconsult). The main agricultural wastes are millet stalks and leaves. Although the leave are valuable feed material when wet, both the leaves and the stalks are in general low in feed value especially when dry and are therefore good candidates for other uses such as conversion to energy. However, the stalks are used extensively for fencing at village level.

Maize**:** It is also a subsistence food crop that is grown throughout the country. The crop is an early variety maturing within about 90 days after planting. The average area under cultivation with maize for the past ten years is 12,872 hectares with corresponding production of 18,177 tonnes. Two waste products can be obtained from maize; the leaves & maize stalks on the one hand and the 'cob-stalks' (this is what remains after the grains are removed from the cob) on the other. The leaves and the stalks are valuable feed materials provided proper husbandry, such as early collection and drying after picking cob, is practised. The cob-stalk is not used as feed. At village level, some of the cob-stalks are used as fuel for heating and cooking through direct combustion and therefore suitable candidate for biomass conversion to low-grade energy. The yield of maize stalks can be calculated from the ratio stalks to grain of 3:1.

Sorghum: It is a subsistence crop with the average land area under maize cultivation over the past ten years being 17,588 hectares. Average production over the same period was 17,885 tonnes (DOP). The main by-products are the stalks and the leaves. The yield of by-product can be calculated from the ratio of by-product to grain of 3:1 (COWIconsult). The leaves and the upper part of the stalk have good animal feed value. However, the lower part of the stalk is highly lignified and not suitable as feed material. This part can therefore be used for other purposes. Like millet, it is also used for fencing at village level thus reducing availability for energy purpose.

Rice**:** In The Gambia, rice is the staple diet of most households. Although most of the rice consumed is imported, a reasonable quantity is grown locally. For the past few years, vigorous efforts are being made to increase rice production and productivity and the area under cultivation has been increasing steadily. We distinguish two types – upland and swamp rice. With increasing incidences of short rainfall cycles in the country and the introduction of high yielding upland varieties such as “Nerica”, the production of upland rice is increasing rapidly. The average land area under rice cultivation (upland & swamp) over the past ten years is 14,540 hectares with corresponding production of 19,563 tonnes. The main agricultural residue (by-product) from cultivation of rice is rice straw. The ratio of by-product to straw is estimated at 1:1 (COWIconsult). Rice straws are valuable animal feed materials when newly harvested and the straws are wet. However, when they are dry and fully cured, they become stiff as a result of the elevated silica content. With increasing animal population, rice straws are mostly used as animal feed on the farm leaving very little, if any, for other uses. This notwithstanding, and The Gambia’s vision of self-sufficiency in rice production, the potential exist for the availability of more rice straws for conversion into low-grade energy.

Cotton**:** This is mainly a cash crop and is grown in the upper part of the country. The area under cultivation with cotton has been declining over past years. According to cultivation and production statistics from the ginnery the average area under cultivation over the past eleven years 1993 to 2003 has been about 2,420 hectares. The average production for the same period has been 1,270 tonnes. The main agricultural by-product is cotton stalk. The stalks are highly lignified and therefore not suitable as a material for animal feed. In fact proper husbandry of cotton farms requires that the stalks are gathered and burnt at field level to avoid pest carry-over, (insects and their larvae) to the following year’s crop. This therefore makes cotton stalks good candidates for use as supplier of biomass energy. The yield of by-product can be calculated from the ratio of cotton-grain to by-product as 1:1 (COWIconsult)

2.1.3. Agro-Industrial Waste

In the Gambia only a few of the agricultural crops are processed at industrial sites. These are mainly groundnuts, rice and cotton. The others being either subsistence crops of low production levels and therefore, processed locally or at scattered locations. The current study will therefore look at the three crops (groundnuts, cotton and rice) to determine availability or otherwise of agro-industrial waste for conversion into low-grade energy by carbonisation and briquetting. Another industrial waste whose generation is increasing and would be similarly analysed in this study is wood dust.

***Groundnuts*:** Groundnuts processing involves decortications to remove the shells and subsequently grading and processing the kernels into other products (HPS, Oil & cake). The waste being considered in this processing activity is groundnut shell. In the Gambia the established ratio of kernels to shells is 70:30. Current uses made of groundnut shells are as fuel in industrial boilers for power generation and as manure. In the past, the GPMB used to burn the shells directly in boiler furnace (direct combustion) to produce steam for power generation to supply electrical energy to run the factory independent of the national grid and also to provide process steam for oil milling and refining. In the past twelve years until 2004, the shells produced at the Gambia Groundnut Corporation’s Denton Bridge factory were largely burnt openly at a nearby dumpsite. Very small quantities, of the order of 1 to 2%, are used as manure by horticulturists. Groundnut shells have very good burning characteristics with low ash and sulphur content as will be shown later.

***Rice*:** The main industrial rice processing in The Gambia takes place at the Kuntaur Rice Mill in CRD North about 200 kilometres from Banjul. The average quantities processed annually are small (Rice Mill Manager), of the order of 200 tonnes compared to the average national production over the past ten years of 19,600 tonnes. The reason for this state of affairs is that most of the rice produced is processed either locally or by using small mobile rice milling machines, emphasising the fact that it is basically a subsistence crop. The latter method often also takes place at farm level. The main by-products from the processing of rice are:

- Rice bran – 8% of input
- Husks, dust & chaff – 30% of input

The rice bran is a very good animal and poultry feed. It is therefore not available for other uses. The husks and chaff are not suitable as feed because of the high silica or silica compound contents. It is however useful as soil filler in swampy fields especially when processing is carried out at the fields. This notwithstanding, any excess, especially from the processing plants, can be used as a source of biomass energy.

***Cotton*:** As stated earlier, cotton production is carried out mainly in the Upper River Division (URD) of the country. Consequently, the only ginning plant in the country is located at Basse (the administrative headquarters of URD). The processing of cotton results in the following average yield of products: -

- Lint – 37%

- Grains (seeds) – 60%

- Waste (dust & dirt) – 3%.

The first two products are exported and cannot be available for any other purpose. The waste, which constitutes mainly of dust and dirt, is not suitable other than as soil filler. Consequently, there is no reasonable amount of agro-industrial waste from the processing of cotton that can be considered as a source of biomass energy. It would not therefore be considered further in the current study.

***Saw Dust*:** There is a mushrooming of local sawmills processing a variety of woods into various timber products. This is happening in the main growth centres of the country especially within the Western Division and the Kanifing Municipality. A lot of waste in the form of wood dust and small cuttings are being generated on a reasonably large scale through this activity. There does not appear to be any major use for these by-products at the moment, except small quantities that are used to start cooking fires and some households use the waste saw dust stoves to cook. The use of these stoves is increasing due to the high cost of fuelwood. The wood dust can therefore be used as a source of biomass energy.

It is however important to note that the use of this resource as a source of renewable energy is open to serious debate in the context of the Gambian situation. There is currently no serious implementable policy on wood plantation for the purpose of timber production. The activities of these sawmills are therefore putting serious stress on the forests, especially when considered that some of the trees are cut illegally. The use of this saw dust, as biomass source of energy intended to reduce stress on the forest cover would therefore seem to be defeated. However, the fact that it is an ongoing activity that is generating a lot of waste requires that the waste be used to reduce further demand on the forests resources for energy – firewood and charcoal.

2.2. Analysis of Residue/Waste Availability

2.2.1 Agricultural Residues

From the above discourse, **Tables 2.1** and **2.2** give the calculated national production of agricultural residues for the crops considered above. Use will be made of data on national production of various crops for the past ten years from Department of (DOP) the ratios indicated above.

Table 2.1: Estimates of National Production of Agricultural Residues (1994-2003 Average) in tonnes

Crop	Cultivated Hectare	Grain Production	Residues Production
Groundnuts[1]	92,825	92,989	139,500
Millet	76,374	78,464	156,900
Maize	12,872	18,177	54,600
Sorghum	16,588	17,885	53,600
Rice	14,546	19,563	19,600
Cotton	2,419	1,270	1,270
Total	**215,624**		**425,470**

(1)The waste being considered here is groundnut hay

Source: DOP – Average of ten Years (1994 – 2003)

As indicated earlier, the use of some of the residues at farm or village level is very extensive as to sometime not to leave any meaningful quantities for other uses. Even where such is not the case, there may be situations where other competing uses other than for the purpose of energy become more cost-effective. The **Table 2.2** gives the estimated excess amounts of wastes after the farmers' needs (for animal feed and/or fencing) are satisfied

Table 2.2: Estimates of Available National Production of Agricultural Residues (1994-2003 Average) in tonnes

Crop	Waste Production	Use of Waste At Farm Level	Availability (Excess)

Groundnuts (Hay)	139,500	65,000	74,500
Millet (Stalks)	156,900	78,400	78,500
Maize (Stalks/Cob)	54,600	32,800	31,500
Sorghum (Stalks)	53,600	32,100	31,500
Rice (Straws)	19,600	12,700	6,900
Cotton (Stalks)	1,270	0	1,270
Total	425,470	295,500	129,970

Source: Calculated from DOP Production Statistics; Ratio of Use COWIconsult

This study did not carry out local needs survey to determine requirements at farm level but used the available information and empirical data from similar studies [COWIconsult] to calculate what is depicted on **Table 2.2**

2.2.2 Agro-Industrial Waste

The Agro-Industrial Wastes production will also be analysed from the totality of production and availability for other uses. Further analysis will be made of amount of this waste left at farm level taking cognisance of the fact that most of the crops processed are both cash and food crops. Therefore, lots of local processing takes place at the village level. **Table 2.3** gives average calculated amounts of industrial wastes for past ten years based on the average tonnages received at the processing centres over the same period. In the case of sawdust, it is the result of interviews with the owners of the local sawmills. The amount of waste remaining in the villages needs to be treated with caution, especially for groundnuts, because of non-formal trading within the country as well as across the borders. It is however the view of the consultants that at least 75% of what is estimated to remain in the villages would be available for biomass conversion into low-grade energy as per the current studies.

Table 2.3: Estimates of Available Industrial Waste (1994-2003 Averages)

Crop	National Waste Production	Waste Production At Industrial Sites	Waste Remaining In Villages
Groundnuts[1] (Shells)	27,800	12,000	15,800
Rice (Husks)	3,300	60	3,240
Cotton	0	0	0
Saw Dust	6675	0	0
Total	31,100 +	12,060 +	19,040 +

(1)The Waste being considered here is groundnuts shell

2.3. Analysis of Alternative Uses of Agricultural Waste

Groundnuts Hay (Fodder)**: Table 2.2** shows substantial amounts of excess groundnut fodder available for other uses order than the needs of the growers for feeding own animals. As a result of its wide use as fodder, the high animal population density and intensive trading in the animals in the urban centers, there is always a high demand of groundnut hay for animal feed. This excess is traded both locally and across the borders. The current price per bag of 5.50kg of the hay is traded in the urban areas of Banjul at D60.00 (D11 per kg). If the hay were converted into biomass charcoal at a maximum carbonization yield of 35%, the cost of such charcoal without considering production costs, depreciation and interest charges of equipment would be D31 per kg or D6.6/MCal (taking the calorific value of hay as 4.5Kcal/kg). The retail cost of locally produced wood charcoal it intends to replace is about D2.86 per kg. The hay charcoal cannot therefore compete with wood charcoal unless the legislation banning the production and sale of wood charcoal is enforced accordingly. Even with such legislation, charcoal briquettes to be produced from this biomass would still be expensive for most households. To encourage the use of biomass fuel products (briquettes or charcoal) efforts must be made and policies put in place to avoid the current practice of supplying wood fuels at low costs.

The wood fuels are relatively cheap because their production is labour-intensive and uses low capital technology, which is not the case in modern biomass fuel production system. Of course, the production of biomass fuel can also be done using low technology and labour-intensive, but more often quality and production efficiencies are compromised in the process. The other use of the hay is as soil enrichment filler but this is normally not carried out because of the lucrative commercialisation of the hay for animal feed.

Millet Stalks**:** **Table 2.2** gives the estimated available biomass for other uses from millet stalks. Once the needs of the growers are satisfied, the balance is normally left in the fields where they are destroyed by bush fires, animals and termites. If marauding animals consume the biomass, there may be net beneficial effects in that the excretion of the animals after consuming the stalks serves to enrich the soil. Thus, if proper collection and transportation strategies are put in place and/or the growers are encouraged to carbonise the materials at farm/village level for sale to the plant (see section on briquetting strategy), over 50% of the available excess can be turned into sources of biomass energy by either briquetting without carbonisation (firewood replacement) or carbonisation and briquetting (wood charcoal replacement).

Maize and Sorghum Stalks**:** The comments made under millet stalks are also valid for the maize and sorghum stalks. The additional available biomass materials from maize are the cob-stalks.

Cotton Stalks**:** The totality of cotton stalks produced is available as biomass for energy generation. This is due to reasons stated earlier that cottons stalks are destroyed (by burning) at field level to avoid carry-over of pest to the next season's crop. Due to declining in cultivation and production, the amount is really not significant.

Groundnut Shells**:** Currently, almost the entire amount of groundnut shells produced during industrial processing is available as a source of biomass energy. However, a distinction must be made between the use of this biomass as domestic fuel and the use of the same as industrial fuel. Installations at GGC factory at Denton Bridge are capable of consuming a total of 63 tonnes of shells per day to produce electricity as against shell generation rate of 95 tonnes per day.

Although the shells are not being used for power generation at the moment, this is not likely to continue for long because of the increasing electricity costs from the national grid. It would therefore be prudent to re-start electrical power generation using groundnut shells in order to reduce the factory's operating cost. This would still be a positive development from a national energy balance point of view as the generation and use of own electricity would allow for the release of what GGC could have drawn from the national grid to other users (avoided purchase of electricity from the national grid). In addition, excess power generated by GGC of the order of 750Kw would be transferred to the national grid. Because of this, the excess amount of 32 (thirty-two) tonnes shells per day from industrial processing is what would be considered as available groundnut shells biomass for conversion into fuel (briquettes/charcoal) for domestic use. There is the additional 15,800 tonnes normally left in the villages, which can also be used for carbonisation and briquetting through a proper and well-structured utilisation strategy. (See suggested arrangements later).

***Wood Dust*:** As indicated earlier, the estimated total generated wood dust from the local sawmills within the urban growth centres is 20-25000tonnes. In theory, this amount is available for the production of biomass briquettes/charcoal, if proper collection and transportation strategies are put in place.

2.4.Projection of Biomass Availability – 5-year Horizon

The production statistics over the past ten years 1994 to 2003 from DOP show the production of the major crops increasing between 6% and 10% (Annex 2.1) as follows:

- Millet – 6%
- Sorghum – 10%
- Maize – 9%
- Rice – 6%
- Groundnuts – 7%
- Cotton – 2.5% (having been declining although slight recovery in the past two years)

Groundnuts production had seen serious fluctuations mainly caused by insufficient precipitation. The cultivation production forecast would be based on 7%, on the assumption of not only increase on the hectarage planted but also on the use of more artificial fertilizer to increase productivity to between 1.5 to 2.0 tonnes per hectare with corresponding increases in waste generation.

Table 2.4 presents the average of the past ten years as (calculated above) the base year (Year 0) and projections are made using the above annual incremental percentages.

Table 2.4: 5-year Projection of Available Biomass for Briquetting

Material	Year 0	Year 1	Year 2	Year3	Year 4
Groundnut Shells	19,900	21,300	22,800	24,400	26,100
Millet Stalks	78,500	83,200	88,200	93,500	99,100
Maize Stalks/Cobs	18,800	20,500	22,300	24,300	26,500
Sorghum Stalks	31,500	34,600	38,100	41,900	46,100
Rice Straws/Husks	6,900+	7,300	7,800	8,300	8,800
Cotton Stalks	1,270	1,300	1,330	1,360	3,400
Total	155,600	166,900	179,200	192,400	206,600

Source: Calculated from DOP Production Statistics – 1994/2003

3. TECHNICAL ALTERNATIVES IN PRODUCING CHARCOAL

3.1 Overview of the Conversion Options

With increasing depletion of fossil fuel but more so the high cost of the same, there is increasing recognition on the use of non-conventional sources to generate energy. Such non-conventional sources (and renewable for that matter) include amongst others: -

- Solar energy;
- Wind power;
- Geo-thermal; and,
- Biomass.

The current study will be confined to the use of biomass and more specifically the use of agricultural and agro-industrial residues to generate energy. Bio-energy offers vast potentials due to the wide spectrum of biomass available for conversion into low-grade energy for domestic use.

Over the years, the conversion of biomass, which include agricultural residues and agro-industrial waste into low-grade energy (some even to high-grade energy) have seen rapid development and wide use. The accompanying technologies and conversion options are also well advanced, although there are still some at the experimental stage. However, the conversion option chosen often has direct bearing on agricultural production and productivity especially in third world countries (agricultural mining of the soil). Brief descriptions of three well established conversion options ensue.

3.1.1. Fermentation Option

This is the microbiological degradation of organic agricultural/animal wastes under specified conditions of temperature, humidity and acidity to produce a flammable gas commonly called biogas. This gas comprises mainly of methane and Carbon Dioxide with traces of other gases such as Hydrogen Sulphite. The process takes place in purposefully design vats, pits, etc. It has gained widespread application and can be designed for the production of biogas for household, village and industrial use. As the volume of gas to be produced increases so is the complexity of the equipment needed for the purpose.

The waste or slurry from the fermentation often impact positively on the environment.

- It is rich in nitrogen and can be used as manure for soil conditioning – thus increasing crop yields. It can also be used in ponds for fish farming thus diversifying the diet of the rural communities.

- It reduces pathogenic bacteriological germs and therefore extremely good for waste management.

- It is reduces environmental pollution.

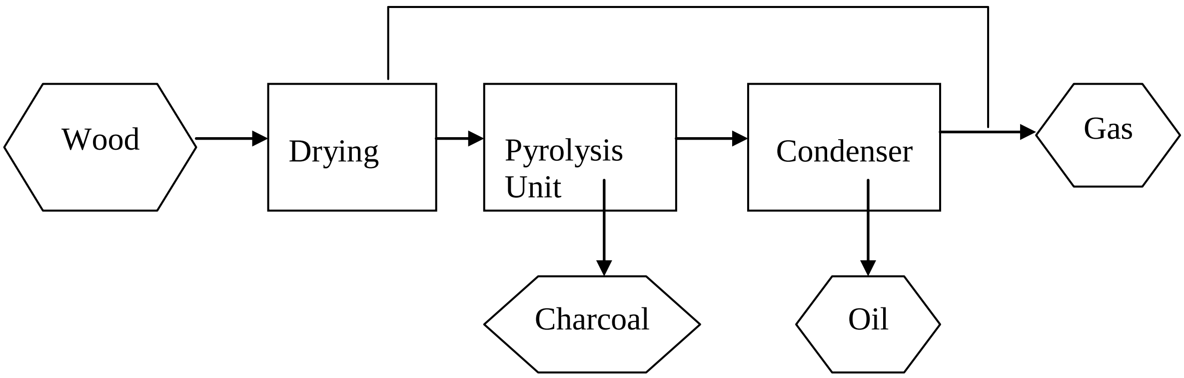
3.1.2. Thermo-chemical Conversion of Biomass

Here we distinguish two processes: - These are direct combustion and pyrolysis (carbonisation)

Direct Combustion – Currently, this is the most widely used for the production of energy from biomass. However, in it most common form, it is also the least efficient causing serious environmental degradation and increasing economic burdens caused by growing scarcity of firewood. Most households in The Gambia depend upon the use of open fires for cooking and heating – wasting a lot of energy in the process. The use of energy saving stoves is still not widespread. The same direct combustion process can be used in boilers to generate steam from agricultural and agro-industrial waste for the production of high-grade energy. For example, GPMB use of groundnut shells to generate electricity and process steam.

Pyrolysis (Carbonisation). It is the thermo-chemical process in which a material is thermally decomposed into less complex, mainly volatile, organic compounds in an air-starved environment (destructive distillation). The products of the process are carbonaceous residue known as char, a combustible gas and an oily liquid. Virtually every form of terrestrial biomass is amenable to thermo-chemical conversion. The process has been mainly applied to wood in developing countries for the production of wood charcoal. However, it is a process that is equally applicable to a wide variety of cellulose materials such as rice husks, groundnut shells, cotton gin waste, etc. (Energy for Rural Development). **Figure 3.1** presents a flow chart of the process

Fig 3.1 Flow Diagram Showing Pyrolysis Process



Source: Energy for Rural Development - Supplement

The main purpose of carbonisation is to considerably increase the calorific value of the end product – charcoal. In the case of agricultural or agro-industrial waste, the main aim beside the above is the production of a product of a sociological nature of similar appearance and quality to the normal charcoal it intends to replace/ substitute.

3.1.3. Mechanical Process – Briquetting.

Briquetting is the application of either mechanical and/or thermo-mechanical pressure to **loose** agricultural/agro-industrial waste or other organic materials with the addition of suitable binder to obtain a product of higher density than the original material in order to ease handling, storage as well as ease of combustion. The technology is well established and it is in use quite extensively in third world as well as developed countries.

Having given the above introduction on the various options available for the conversion of biomass into a variety of energy forms, this study will concentrate on the use of therino chemical conversion methods – briquetting and pyrolysis. It will further be confined to the use of agricultural or agro-industrial wastes in The Gambia. The environmental impact of each process will be outlined when the processes are discussed in detail in subsequent sections of this chapter

3.2 Processing Technologies

One of the major shortcomings of the biomass considered in this study is the issue of low bulk density (a characteristic of almost all biomass). This always increases transportation costs because of the low weight carried for a given volume. Since the various biomass sources are also distributed throughout the country, two options could be considered to partly offset this state of affairs.

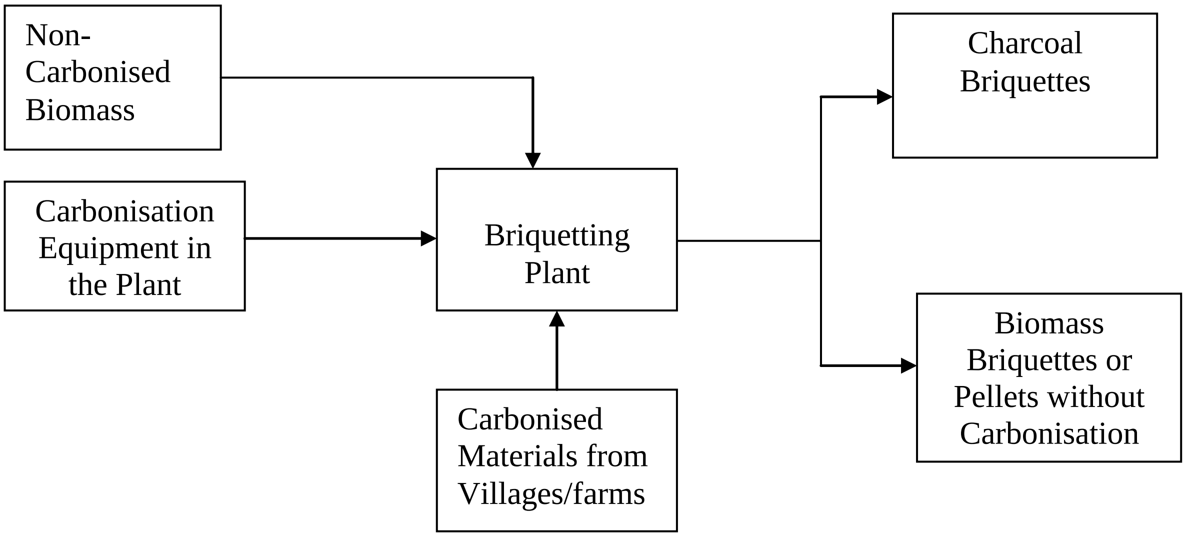
- Centralised Processing Location

- De-centralised Processing Locations

Each option has its merits and demerits. In the case of centralised location, it allows for the installation of sizeable plants reducing greatly the capital outlay (installation of numerous small units) as well as enjoying the economies of scale. However, the transportation of the biomass to the central location can be prohibitive, which could have negative influence on the unit cost of the final product. For the decentralised locations, it would require the installation of small units all over the place. This would increase the capital outlay and maintenance costs. It has however the advantage of providing employment to the local communities as well as reducing transportation costs. It would contribute towards poverty alleviation in the rural areas.

The current study would however recommend a third option. It is view of the consultants that in the process of converting the available biomass into fuels, certain activities should be carried at field level so as to benefit the primary biomass producers. The proposal here is in view of the high technology required for briquetting, the briquetting plant should be located at a strategic location. Almost all briquetting activities will be carried out here. Where biomass charcoal is to be produced, the carbonisation process should be carried out at village/farm level. Quality and processing yield may be compromised but this could be improved by the use of slightly improved technology such as the use of oil drums as kilns for carbonisation. The carbonated material would then be sold to the briquetting factory where it is ground and briquetted with the addition of suitable binder. In this way transportation would be reduced greatly because the carbonised material would have higher bulk density than the original loose material, but most importantly also the arrangement will provide employment at village level especially during periods when farming activities are almost over. Besides, biomass materials remaining in the villages such as rice husks, rice straws, groundnut shells and a wide range of other biomass material will be available for conversion into fuel, thus improving production levels. **Figure 3.2** depicts the flow chart of the recommended processing arrangement: -

Fig 3.2 Block Diagram Showing Proposed Processing Arrangement



Having established the available biomass in the country, we now look at the paths to converting the same into a form that is appealing to the user. As stated earlier, the study will concentrate on only two conversions options as per the terms of reference. The two options we would be analysing are: -

- Briquetting to produce only briquettes or pellets

- Carbonisation and briquetting

The path chosen for the treatment of any biomass will depend on the type of domestic fuel to be replaced; if firewood is required to be replaced, then briquetting only without the need for carbonisation would suffice as the briquettes thus produced will have similar burning characteristics as firewood – slight smoking during start-up of the fire. Palletising will give added advantage in terms of ease of start of the fire and less smoke. However, if wood charcoal is to be replaced, then a product of similar characteristic and appeal would have to be produced from the biomass. This would require carbonisation and briquetting or briquetting then carbonisation. The option chosen has a direct bearing on the quality of the product. Two major alternatives exist to producing biomass briquette charcoal: -

- The raw materials are densified by briquetting and then carbonised. This would normally result in fairly expensive briquettes, as high investments are required to densify the raw biomass into a acceptable quality briquettes, and the resulting briquettes are often of low and non-consistent quality compare to wood charcoal

- The raw materials carbonised and then densified by briquetting. This is a lower cost solution as the densification process can be simpler (a simple press that uses binder to form briquettes of charred materials), and the briquettes are of uniform and consistent quality [R. J. van de Plas]

3.2.1. Briquetting

Biomass in general has low bulk density. It is therefore very costly to transport as it occupies high volume with low weight. In its loose form, biomass has poor combustion efficiency. The purpose of briquetting is therefore to transform the loose biomass material into a compact highly compressed form. This is done by the application of mechanical energy to press the material by adding a binder. The binder helps to improve the homogeneity and cohesiveness of the final product. The change in form results in a product of higher specific density and increases combustion efficiency, when compared to the original loose biomass material. Most cellulose materials are amenable to briquetting [Energy for Rural Development]

The technology of briquetting is now well established and is in use quite extensively. It is important to note that in briquetting, certain parameters are important in determining the characteristics and quality of the end product [COWIconsult].

- The pressure applied during pressing
- The duration of pressing
- The size and shape of the briquettes
- The physical properties specific to the materials in use, its water content, temperature and the pre-treatment carried out on the input biomass material.

There is a volume reduction, which is a decreasing function of the pressure applied until the maximum density is reached for a given material. When the pressure drops at the end of the briquetting, a volume expansion takes place. This expansion depends on the above parameters.
The water content affects the end product because of the increase/decrease in elasticity. If the water content is too high, the briquettes will show poor cohesion because the expansion will be too great. If the water content is too low, the briquettes will be friable and of poor quality. The recommended water content should be between 10 – 15% otherwise; drying would be required [COWIconsult]. The application of temperature allows for the changes in the structure of the material being pressed through the release of bonding substances, which increases cohesion. When briquettes are pressed with the application of heat, this results in a reduction in applied pressure for a given density of briquettes.
The size and shape of the briquettes have an effect on the appeal to the user. The modern trend is to go in for pellets as they have smaller diameter and tend to burn better with better release of heat as well.

Technology

Briquetting is a well-established technology and it is in use in the many countries. It is easy to operate and maintain, as there are few equipment in the briquetting plant that would require specialist attention. Basic operational and maintenance training would be all that would normally be required to efficiently operate and maintain the plant. It is however important to note that thorough analysis of the input material should be carried out at the initial stages of designing the plant as certain agricultural wastes contain hard elements, which would results in rapid wear and tear on some of the equipment – increasing maintenance cost and reducing the life span of equipment. This is more so in the presses.
The basic equipments in briquetting plant are the following: -

- Hydraulic press(s);
- Silos;
- Cyclones;
- Conveying system; and,
- Pre-treatment equipment (hammer mill, grinders, chopping, etc).

Yields: Generally briquetting results in minimal loss of material; between 5 - 10% of input is lost during briquetting.

Reliability, Life Span & Impact on the Environment

The technique of briquetting is quite reliable with wide applications in many fields. The life spans of the various components that make up a briquetting plant differ. The presses, which go through a lot of cyclic stresses normally, have life spans of about five years, whilst other equipments have life spans of about 10 years.
Briquetting of biomass for fuel use would naturally remove nutrients from the soil and therefore would not allow for conditioning of the same. Agricultural residues that could have been used for this purpose are removed from the fields for energy production and this is tantamount to 'soil mining'. In a situation like The Gambia where there is never enough affordable artificial fertilizer, the long-term effects would be to reduce soil fertility and therefore reduced agricultural production and productivity. However, this would be countered by a reduction in the cutting down of trees for fuel, which has a greater negative environmental impact. If affordable artificial fertilizer is available, this would ameliorate the effect of soil degradation and therefore the biomass would become a source of renewable energy.

3.2.2. Carbonisation (Pyrolysis) of Agricultural Residues

As defined earlier, Carbonisation or Pyrolysis is a thermo-chemical process in which a cellulose material is thermally decomposed into less complex organic compounds in an air-starved environment. The products of the process are usually solid char, gaseous compound and an oily liquid. See **figure3.1** above. The quality and quantity of the various products depend on the following: -

- Operating temperature;
- Heating rate; and,

- Residence time and pressure applied.

The objective of the present study is the maximisation of charcoal production using the carbonisation process. This therefore requires low reaction temperature of between 300 – 400ºC and a high residence time. The yield of charcoal from carbonisation can be as high as 35% [Energy for Rural Development] when highly efficient systems are used.

The charcoal produced from the carbonisation process of biomass is similar in characteristic to the traditional wood charcoal, which is also always produced through a similar process – wood carbonisation. It is therefore a suitable and sustainable replacement to wood charcoal. The oil produced can be mixed with the charcoal to enrich it whilst the gas, which is of low calorific value, can be used for the pre-treatment of the input raw material such as drying. It should to be noted that the oil is corrosive and in traditional carbonisation, it is often lost to the soil when sand moulds are used for the carbonisation process.

Technology & Process Description

In traditional settings, the process involves the collection of cellulose materials be they branches of trees or biomass and placing them in a pile and burning them in without air (oxygen). To starve the process of air, the pile is usually covered with earth. The above method often results in low yield and highly contaminated product. As a result of advances in technology, new techniques are now used which result in high productivity as well as better quality of products.

Carbonisation or Pyrolysis can be carried out as batch process or as continuous process. For areas lacking capital earth-covered kilns, pits are generally used. However, kilns constructed of bricks, concrete and metal allow for better control of yields and eliminate contamination of products [Energy for Rural Development].
There are two types of kilns: fixed and portable. The choice of type depends largely on the location of the available biomass supply and relative cost of labour. In their simplest form 200-litre oil metal drums can be fabricated into kilns and therefore be made portable. However, kilns manufactured of metals can be very strong to withstand high pressures. In the batch process using the above-described kilns or earth-covered pits, the other products of the pyrolysis, gas and oil, are normally lost.

The other equipments, which applied advanced technology, are the retorts. They overcome the disadvantages of kilns of not being able to recover the other products (kilns fabricated of metals can be arranged to allow for the collection of these products). The retorts allow for better control of the process parameters, which results in better yield of the desired product – in our case charcoal. However, retorts are quite expensive to manufacture and in our situation, the final product may be too expensive for the population it intends to serve.

As stated earlier the maximisation of any of the products depends on the regulation carried out to the process regulating parameters of temperature, residence time and heating. In the developed world, the emphasis is the maximisation of other products – oil and gas to ease transportation and for application in power generation (gas turbine) or the transport sector.

The basic equipments needed for carbonisation are either: -

- Kilns (of various types and size) or Retorts

- ♦ Dryer, which can use the gas for drying
- ♦ Cyclone for removal of particles from the other products
- ♦ Condenser for condensing and collection of the oil

Reliability& Life Span

The reliability of carbonisation depends on the technology used. In the case of earth-covered pits the product is often of uneven quality with large percentages of losses and lots of unburned pieces. The use of kilns and retorts improves the quality of the charcoal.
As a result of the corrosive properties of the oil, the lifetime of the major equipments in carbonisation is very short. It various between one to five years and depends on the material use. In industrial settings, it cannot exceed ten years (COWIconsult).

Energy Yields

The energy yields depend entirely on the process chosen and the scale of technology applied. **Table 3.1** below gives indicative yields [COWIconsult]:

Table 3.1: Energy Yield of Alternative Carbonisation Technologies

Equipment	**Yield**
Traditional Pile	18%
Improve Pile	28 – 30%
Earth Pile	30 – 48%
Jamaican Retort	32 –48%
Kilns (CUSAB, Tonga & New Hampshire	22 – 35%

Impact on the Environment

The comments made with regards briquetting applies here. In addition pyrolysis is a source of atmospheric pollution and of soil pollution because the oil will partly sip into the soil even where it is collected.

3.2.3. Plant Installation Proposal

This study proposes the installation of a briquetting plant incorporating carbonisation equipment. The proposed location should be preferably at Denton Bridge or anywhere within the Banjul/Kanifing Municipalities. The reasons are as follows: -

- ♦ To make maximum use of the available groundnut shells currently not being used for any significant purpose. The availability of shells is guaranteed even in the future when the power plant becomes operational;

- The major consumption centres for the products are within these municipalities. This will therefore reduce transportation and distribution costs and make the product affordable;

- There is growing amounts of saw dusts within these municipalities which could be transported at minimal costs to the processing centres;

- The carbonated biomass materials from the villages as per proposal will be easily transported using river barges, which have a lower transportation tariff compared to trucks;

- The supply of electricity to the plant can be obtained from the national grid, which is cheaper than installing own generators;

- There is a briquetting plant at Kaur, which if found necessary can be repaired and put into operation at a minimum cost to produce non-carbonated briquettes.

Plant Layout

Although as per the proposal, a lot of carbonated materials would be received from the villages through a network of sales outlets, it is proposed that a metal kiln capable of meeting the daily briquetting requirement of the plant is incorporated. This would allow for the in-situ carbonisation of the biomass available within Denton Bridge and municipalities – groundnut shells and saw dust.

The plant should also be capable of producing non-carbonised briquettes or pellets, which can be sold to customers who only require firewood replacement fuel, see **figure 3.2**. Pellets have been found to have very good burning characteristics and are cheaper to produce compared to carbonisation. Thus, with proper marketing strategy, they should sell very well.

Plant Capacity

From the above biomass availability analysis and taking into consideration the transportation logistics, the disperse nature of the available biomass (distributed all over the country), and future use of the shells for power generation at Denton Bridge, we suggest the installation of a plant with processing capacity of 4 tonnes/hour. The operating hours can be made flexible depending on the flow of the raw materials. On a 24-hour 3-shift system, the plant will be capable of producing 96 tonnes of product a day, whilst on a 16-hour 2-shift system, the production would be 64 tonnes per day, at 100% utility factor. We would recommend a 2-shift system and the economic analysis that follows will assume this scenario. The potential exists to increase the plant capacity to 6 tonnes per hour (144 tonnes per day), depending on the efficiency of the collection of the carbonised biomass from the villages.

Plant Equipment

As stated earlier, the plant equipment should meet the expected output as well as maintain the quality of the product at all times. This study is proposing two systems that would be integrated into a whole – a carbonisation process and a briquetting process. The plant would thus have the following major units: -

- **Silos:** These are required to hold the materials to ensure continuous production.

- **Carbonisation unit:** will comprise mainly of metal kiln(s) to carbonise the materials in-situ.

- **Sizing up unit:** This would include cutter/chopper for cutting and chopping of raw materials like cotton stalks, rice husks, etc to suitable size for grinding and briquetting. It would also include a hammer mill to grind the materials to achieve consistent and uniform size for briquetting. The size can be varied using different screens and sieves.

- **Conveyor system:** This would comprise conveyors and blowers to transfer materials and products from one stage to next.

- **Dryer/Dosing Unit:** It may sometime be necessary to dry material prior to briquetting, especially if the moisture is above 15%. With some materials there may also be a need to add a binder to ensure compactness and proper homogeneity of the product.

- **Briquetting unit:** The unit will comprise the presses that would do actual the briquetting of the materials.

- **Lubrication system:** Certain critical areas of the presses are under high pressures and also at metal-to-metal contact. To ensure long life of the presses, force lubrication needs to be carried out.

- **Bagging & Weighing Facility:** This is to bag and weigh the products (briquettes or pellets) prior to storage or sale.

3.2.4. Manufacturing Process

The biomass material will be tested in terms of chemical composition to determine suitability or otherwise. Its moisture content should be between 10 – 15%. If the moisture content is higher than, it would require drying using hot air, which can be generated from a blower. If however the material is too low in moisture content then water will be added.
The material is screened, chopped and ground to get the required size and bulk density and is pneumatically transported into to storage bins. This assists in unifying the moisture content of the materials. The material is transferred to the briquetting presses to produce the briquettes. The product is cooled by ambient air, bagged and packed in the warehouses for sale.

3.3 Analysis of the Biomass Materials Available for This Project

This analysis will tabulate the biomass available as reviewed above, giving their calorific values and ash content.

Materials	Calorific Value Kcal/kg	Ash Content %
Groundnut Shells	4,780	6.9
Cotton Stalks	4,360	6.7
Maize Stalks/Cob	4,150	1.8
Millet Stalks	4,200	2.0
Sorghum Stalks	4,200	2.0
Rice Husks	3,500	19.5

Saw Dust	4,300	2.0

Source: Facilitation India Private Ltd

It can be seen that the biomass considered have very good calorific values comparable to fossil fuels (e.g. Coal Grade B with a value of 5,000 Kcal/kg and Grade C with 4,000 Kcal/kg). The biomass has the added advantage of low ash and sulphite content – thus reducing atmospheric pollution with sulphuric acid – so-called acid rains.

3.4 Estimated Cost of Materials:

Most of the biomass materials considered, except of groundnut hay, are not on sale at the moment. The groundnut hay will not be considered further because as stated above, it is not a cost effective material for conversion into energy because of the lucrative trade on it for animal feed. However, as regards the other biomass, it has to be accepted that as soon as use is made of the materials, they would obviously attract a price. This study will analyse the cost of materials from the point of view of the materials that would be carbonised at the plant and the carbonised materials from the villages. At village level, the raw material cost would be initially zero-rated. The cost would be analysed from the point of labour, carbonisation and transportation costs. A margin would then be added to take care of the material cost – after all the material would have been thrown away. See **Appendix 3.1**. The transportation cost assumes the collection of materials by designated agents, who then transport them to collection centres (GGC Depots) for final transportation to the plant by river barges.

IV. ENTERPRISE OPTIONS AND FINANCIAL VIABILITY

4.1 Enterprise Options

Biomass conversion into energy, especially through briquetting often provides employment to the portion of the population most involved in its production. In The Gambian context, it is mostly the rural farmers who are involved in the generation of the bulk of the biomass. However, putting up small briquetting plants at every hamlet would not be cost effective as production costs are often high because of low output. This study would look at three possible enterprise options.

4.1.1. A Limited Type Enterprise:

In this option, one can consider an agro-industrial organisation like the Gambia Groundnut Corporation involved in the processing of the main crop (groundnuts), which generates a lot waste (groundnut shells) getting involve in the enterprise. The Corporation would therefore buy, build, own and operate the briquetting plant and sells the product through a network of agents. The advantages of getting GGC involve in such a venture are numerous: -

a) Availability of the main agro-industrial waste – groundnut shells within the complex where the briquetting plant would be located, thus reducing transportation costs.
b) Availability of certain physical infrastructures such as land and buildings to house the plant. There would therefore be no need to purchase land and put up buildings, as existing building would be used. The only cost in this direction would be the refurbishment of these structures. This would reduce greatly the unit cost of the product as most of these structures are fully depreciated.
c) The provincial depots of the corporation can be used as collection centres for the carbonised biomass from the villages. From these depots transportation of the material to the processing centre can be done by use of river barges, which is cheaper thad transportation.
d) Distribution of the biomass charcoal can also follow the same route in reverse to consumers in the rural and/or provincial growth centres.

4.1.2 Producer Organisation Type Enterprise:

In this option, an established and registered cooperative producer organisation can get involve in the procurement, installation and operating the plant. With many Non-governmental Organisations willing to assist farmer organisations to build capacity with a bid to reducing poverty, such a producer organisation can seek funding from the NGOs in financing the project. In the Gambian context, such farmer organisation would naturally be Federation of Agricultural Cooperative Societies (FACS), with its network of Cooperative Produce Marketing Societies (CPMS). The advantages of such set up are: -

a) A large portion farming community would feel the ownership and would cooperate and support the enterprise.

b) The CPMS would be collection centres for the biomass as in the marketing of the main crop – groundnuts. They would serve as sales outlets for the product, if it becomes desirable.
c) The CPMS members would be involved in the carbonisation of the biomass at village level and taking the carbonised material to their CPMS' for sale.
d) It would help in poverty eradication in that with an average total available biomass of about 180,000 tonnes, yielding about 45,000 tonnes of carbonised material, GMD35.0m could be easily transferred to the rural areas.

4.1.3 Joint Stock Venture Type Enterprise:

Here the two options outlined above are merged. In this context, GGC and FACS can form a joint venture, each putting its resources, expertise and logistical advantages into the fore. The advantages are obviously a combination of what has been listed in each of the first two options. There would be creation of jobs in rural areas.

4.2 Preliminary Financial Analysis

The estimated cost of plant and equipment is **GMD 4.5m** See **Appendix 4.1** for details. This includes the cost of plant & machinery, land, installation & commissioning, training, manpower and maintenance.

4.2.1. Economic Analysis of The Plant

Installed Capacity (kg/hr)	4,000
Capacity Utilization (%)	80
Working hours per day	16
Working days per month	25
Monthly production (t)	1,280
No. of months per Year	10
Annual Production (t)	12,800
Wastage of Raw Materials (%)	5
Annual Requirements of Raw Materials (t)	13,475
Price of Raw Materials (GMD/t)	625
Annual Cost of Materials (GMD)	8,421,875
Consumption of Water (cum./day)	6
Cost of Water (GMD)	1,500
Consumption of Electricity (kw/h)	200
Cost of Electricity (GMD)	644,000
Labour per Shift	8
Labour Cost (GMD)	225,000
Interest &Depreciation @15%	570,000
Overhead Charges (GMD)	500,000
Miscellaneous (GMD)	250,000
Total Cost (GMD)	10,612,375
Unit Cost (GMD/tonne)	829

It is assumed here that funding for the project would be obtained from overseas (dollar based) so that interest would not be more than 5%. The plant and equipment are being depreciated over 10-year period. This equates to D0.83/kg or D0.18/Mcal. Wood charcoal is being sold at an average retail price of D85.00 per 28kg bag, which is equivalent to D3, 036.00 per tonne within the urban areas. This translates to D3.04/kg or D0.43/Mcal. The calorific value of groundnut shells briquettes is taken to 4,700Kcal/kg and that of wood charcoal at 7,000Kcal/kg. If the carbonised biomass charcoal is even sold at about D1, 500 per tonne, there would still be a profit margin over 80%.

4.2.2. Cost of Raw Materials Analysis

1. Groundnut Shells at Factory

Unit Cost of Materials (GMD/t)	150
Carbonisation Yield (%)	25
Cost of Carbonised Materials (GMD/t)	600
Labour (GMD/t)	25
Total cost of Carbonised materials (GMD/t)	**625**

The depreciation cost for the carbonisation equipment is to be considered as part of the entire plant and depreciated therein.

2. Biomass Materials at Village Level

Unit cost of Raw Materials (GMD/t)	0
Man-days to Carbonise Materials (1/t)	8
Rate per man-day (GMD)	35
Total cost of Production (GMD/t)	200
Margin @ 15%	30
Transportation Cost (GMD/t)	375
Handling – Loading & unloading (GMD/t)	20
Total Cost of Carbonised Materials (GMD/t)	**625**

Previous studies in The Gambia have shown that it requires about one man-day to produce one bag of wood charcoal weighing about 28kg [Hoff & Overgaard A/S]. Since the production of wood charcoal involves the cutting and collection of wood, which is time consuming, it is estimated here that with biomass which will not involve lengthy cutting and collection process, about 0.2 man-days would be required to produce one bag of biomass charcoal. This is the basis used for the above calculation in the carbonisation process of the biomass at village level.

5. LEGAL, FISCAL AND REGULATORY INCENTIVES

5.1 Legal Incentives

From **Table 2.4** the average total available biomass is about 155,000 tonnes increasing to 206,000 tonnes within the five-year projection. This is the available biomass, which technically can be converted into energy of one form or the other. Even if 50% of this is utilised and converted into biomass charcoal at conversion efficiency of 25%, a total of between 20,000 to 25,000 tonnes of biomass charcoal briquettes can be produced. This is more than the estimated national consumption of wood charcoal. With better collection and carbonisation strategy, the percentage utilisation of the biomass can be greatly increasing, resulting in biomass charcoal production in excess of the national need.

In the light of the above, this study would recommend that the following legal incentives should be put in place to ensure viable charcoal production from biomass: -

- Total ban on production of wood charcoal in the country.
- Progressive increase of licence fee on importation and distribution of wood charcoal by about 200% in two years.
- Heavy penalties in the event of evasion of licence fee.

5.2. Fiscal Incentives

In order to encourage production and sale of charcoal, the following fiscal incentives should be granted to the enterprise: -

- Allowing for 100% depreciation
- Financing subsidy to encourage the setting of such projects
- Low interest rate on loaned funds
- Exemption of tax (sales, income, etc) on income generated from this activity
- Encouraging NGO participation, especially at village level. In our case, in local briquetting projects at village level
- Exemption of duty on all items imported for the production of biomass briquettes.

5.3 Regulatory Incentives

Once a heavy licence fee is imposed on the, importation, distribution and marketing of wood charcoal, the following regulatory framework should be put in place: -

- ♦ A well-structured quality control inspection system headed by the department of forestry in collaboration with national energy department to ensure that the biomass charcoal is of high quality to meet the expectations of the consumers.

- ♦ The forestry department, the police, customs and the immigration departments should be involved in ensuring that the new licence rate is strictly adhered to.

BIBBLIOGRAPHY

1.Study on the Efficient Utilization of Agricultural By-Products as Domestic Fuel in The Gambia – UNSO/DANIDA by COWI consult Consulting Engineers and Partners A/S

2.Energy for Rural Development – Supplement, US Board on Science & Technology for International Development

3.Evaluation of Groundnut Shells Briquetting Scheme in The Gambia by Hoff & Overgaard A/S

4.Energy Issues by Robert van der Plas www.worldbank.org

5.Energy Policy by Robert J van der Plas, Mahamat Ali Abdel-Hamid – www.elsevier.com/locate/enpol

6.United States Department of Energy website

7.Renewable Energy – Worldwide website

8.www.fao.org

9.www.chardust.com

10.www.btgworld.com

Appendix 1.1 Analysis of Electrical Power Generation Potential from Groundnut Shells Through Direct Combustion

Assumptions

- Total commercial crop of 100,000 tonnes of groundnuts in shell
- 60,000 tonnes to processed at Denton Bridge and 40,000 tonnes at Kaur
- Maximum operating period 200 days
- Average kernel to shell ratio 70:30
- Average kernel carry over with the shells 1.2%
- Average of shells content in the FAQ 2%
- The calorific value of the shells 4,780 Kcal/kg (20,076 KJ/kg)

<u>At Denton Bridge</u>

Available shell flow rate	=	(60,000 x 0.3 x 0.98)/(24 x 200 x 0.988)		
	=	3,720kg/hr		

At a combustion efficiency of 75%, the energy available will be

	=	3,720 x 20,076 x 75%	=	56GJ/hr
Power Equivalent	=	56/3600	=	15.6MW

In thermal power generation, this amount of energy is never available as power output. This is because the conversion equipment absorbs a large amount of energy; latent heat the steam is never available for power generation. There is also a great heat loss in the flue gases.

The boilers at GGC are capable of burning 2,636 kg/hr of groundnut shells to generate 12,388 kg/hr of steam at 18.5 bar gauge pressure, at superheated steam temperature of 350ºC (Babcock Power Ltd). Hence, with a shell flow rate of 3,720kg/hr, steam generation rate of the same conditions will be

= (12,388 x 3720)/2636 = 17,480kg/hr

At steam condition of 18bars, 350ºC at the turbine stop valve, 6,350kg/hr of steam will generate 1.0MW of power. Taking steam flow rate efficiency across turbine blades of 96%,

Power to be generated = (17,480 x 0.96 x 1.0)/6350 = **2.65MW**

At maximum power consumption at Denton Bridge Complex of 300 – 400Kw, this would leave over 2.2MW of power that can be sold to the national grid. In the event of improvements at Denton Bridge to increase consumption to about 1.0MW, over 1.5MW would still be available to the national grid.

<u>At Kaur</u>

By the same analysis, shelling 40,000 tonnes at Kaur would generate about 12,000 tonnes of shells. As Kaur has no power generation facility, the shells could be briquetted (there is a briquetting plant at Kaur) or pelletised and transported to Denton Bridge to be used for firing the boilers. This amount of shells would be capable of generating the same amount of power, as stated above, for over 100 days.

During this period Denton Bridge would have completed processing and practically the entire amount of power generated (2.65MW) would be available to the national grid. Even when GGC is in operation, the power it consumes through own generation can be considered as avoided power from the national grid, which would thus be available to other consumers.

Appendix 2.1: Preliminary Survey of Available Saw Dust from Local Sawmills

A survey was carried out to establish the amount of sawdust being generated by the local sawmills, which are scattered over the country, especially in the urban areas. A number of sawmills were visited and the following questions were asked: -

a) Name of Owner/Sawmill?
b) How many bags of sawdust are produced daily?
c) What is the approximate weight of each bag?
d) To what use is the sawdust being put to currently?
e) Suppose there is a request from an established institution, what relationship would they want to establish with that institution in as far as the disposal of the sawdust is concern?

The answers to the above questions varied. At the start, the personnel who conducted the survey were asked to inform the owners of the sawmills that the survey was private and not intended for any taxation or so.

Table of Daily Generation Rate of Sawdust

Name of Sawmill	No of bags	Weight (kg)	Disposal	Total (kg)
King One Heart Sawmill Enterprise	25	15	Free	375
Kessekoi Trading Enterprise	35	15	Free	525
Juju Woodwork & Sawmill	75	15	Free	1125
Batosita Sawmill	40	15	Free	600
O Malacks & Sons Ltd	30	15	Free	450
A.J.C Workshop	25	15	Free	375
Fakebba Sawo Sawmill	70	15	Free	1050
Madi Cessay Sawmill	25	15	Free	375
Lamin Darboe Sawmill	20	15	Free	300
Sambou Minteh Sawmill	25	15	Free	375
Bayo Kunda Sawmill	20	15	Free	300
Malick Samura Sawmill	20	15	Free	300
A. Trawally Sawmill	35	15	Free	525
Total		15		**6,675**
Average per Sawmill		15		**513**

As regards the first question, the personnel interviewed willingly gave the name of the sawmills/owner. Some even gave out their business cards. As regards the number of bags produced daily, various figures were given as shown in the table below, which is a reflection of the size the sawmill. The answers to the weight of each bag varied from 25kg to 50kg; some would say “a bag of rice” – meaning 50kg. However, samples of bags taken gave average weight of 15kg. On the issue of the disposal, all said they always give out the dust free to women as a means of cleaning their working environment. In the event of an established institution wanting the sawdust, some sawmill owners said they would sell the dust at a ‘reasonable’ price. The price range quoted being between D3.00 to D10.00 per bag. Others said they would still give out the dust free of charge as long as their working environment is kept clean. The latter can be ignored, as it would not last long before they start charging for the dust.

Comments:
Estimates are that, there are over 100 Sawmills within the Greater Banjul Area (KMC & WD). Interview with the owners of Nyambai Sawmill, which is a big industrial set up, indicates that lots of sawdust is being generated there. From the above survey, and limiting the operating period for most sawmills at 200 days per year (limitation on electricity supply), and taking the Nyambai Sawmill, it

can be estimated that over 20 -25,000 tonnes of sawdust is being generated annually. In fact, some sawmills visited have disposal problems at the moment. This amount of sawdust can produce over 5-6,000 tonnes of biomass charcoal, already about 25% of the annual national charcoal requirement.

Appendix 3.1: Area Under Cultivation & Production of Various Crops

Crop	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Average
Early Millet											
Area Planted (ha)	40,001	42,361	42,632	59,780	53,517	63,400	71,800	81,273	86,524	95,539	63,683
Average Yield (Kg/ha)	1,102	1,026	1,161	909	1,039	1,146	1,092	1,095	894	1,121	1,059
Total Prduction (Mt)	44,086	43,444	4,950	54,366	55,596	72,700	78,500	89,018	77,341	107,138	62,714
Late Millet											
Area Planted (ha)	9,787	12,833	13,070	13,673	13,791	8,800	14,010	16,087	10,459	14,399	12,691
Average Yield (Kg/ha)	895	824	918	857	658	950	1,150	992	696	917	886
Total Prduction (Mt)	8,761	10,576	11,992	11,716	9,070	8,300	16,100	15,953	7,277	13,204	11,295
Sorghum											
Area Planted (ha)	8,431	13,987	12,699	13,432	12,232	16,200	19,700	26,175	18,337	24,684	16,588
Average Yield (Kg/ha)	1,056	849	1,080	962	807	1,107	1,261	1,277	829	1,221	1,045
Total Prduction (Mt)	8,903	11,873	13,719	12,928	9,869	17,900	24,900	33,418	15,209	30,130	17,885
Maize											
Area Planted (ha)	10,547	10,551	8,217	7,240	9,073	12,800	13,700	17,202	18,350	21,044	12,872
Average Yield (Kg/ha)	1,262	1,292	1,220	1,169	1,434	1,597	1,609	1,685	1,013	1,585	1,387
Total Prduction (Mt)	13,315	13,633	10,021	8,466	13,011	20,400	22,000	28,988	18,580	33,353	18,177

Appendix 3.1 (cont.)

TOTAL COARSE GRAIN											
Area Planted (ha)	68,766	79,732	76,618	94,125	88,613	101,200	119,210	140,737	133,670	155,666	105,834
Total Prduction (Mt)	75,065	79,526	40,682	87,476	87,546	119,300	141,500	167,377	118,407	183,825	110,070
Upland Rice											
Area Planted (ha)	2,888	2,751	4,333	6,342	7,683	6,900	7,100	8,915	6,079	8,862	6,185
Average Yield (Kg/ha)	1,268	1,222	930	1,029	1,040	1,292	1,414	1,108	762	1,104	1,117
Total Prduction (Mt)	3,661	3,363	4,029	6,523	7,900	8,900	10,100	9,878	4,632	9,783	6,877
Swamp Rice											
Area Planted (ha)	10,281	12,652	12,700	6,342	8,315	5,400	6,000	6,953	3,773	6,661	7,908
Average Yield (Kg/ha)	1,615	1,232	1,115	1,029	1,304	1,749	1,774	1,341	662	1,313	1,313
Total Prduction (Mt)	16,606	15,589	14,156	6,523	10,846	9,400	10,600	93,222	2,498	8,230	18,767
Irrigated Rice											
Area Planted (ha)						2,227	2,300		2,300	2,227	2,264
Average Yield (Kg/ha)							5,825		5,000	5,000	5,275
Total Prduction (Mt)						13,365	13,400		11,500	11,500	12,441
TOTAL PADDY											
Area Planted (ha)	13,169	15,403	17,033	12,684	15,998	14,527	15,400	15,868	12,152	17,750	14,998
Total Prduction (Mt)	20,267	18,952	18,185	13,046	18,746	31,665	34,100	103,100	18,630	29,513	30,620
TOTAL CEREALS											
Area Planted (ha)	81,935	95,135	93,651	106,809	104,611	115,727	134,610	156,605	145,822	173,416	120,832
Total Prduction (Mt)	95,332	98,478	58,867	100,522	106,292	150,965	175,600	270,477	137,037	213,338	140,691

Appendix 3.1 (cont.)

Crop	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Groundnuts 73/33											
Area Planted (ha)	9,712	25,439	15,876	18,691	21,007	23,600	27,400	36,109	30,411	38,912	24,716
Average Yield (Kg/ha)	954	976	720	1,138	1,026	1,395	1,314	1,170	646	884	1,022
Total Prduction (Mt)	9,269	24,822	11,434	21,272	21,546	32,900	36,000	42,246	19,655	34,400	25,354
Groundnuts 28/206											
Area Planted (ha)	65,369	52,647	48,537	51,767	49,472	75,600	90,700	102,779	75,196	69,026	68,109
Average Yield (Kg/ha)	1,094	956	708	1,098	1,049	1,192	1,124	1,059	690	959	993
Total Prduction (Mt)	71,535	50,356	34,388	56,829	51,911	90,100	102,000	10,823	51,871	58,538	57,835
TOTAL GROUNDNUTS											
Area Planted (ha)	75,081	78,086	64,413	70,458	70,479	99,200	118,100	138,888	105,607	107,938	92,825
Total Prduction (Mt)	80,804	75,178	45,822	78,101	73,457	123,000	138,000	53,069	71,526	92,938	83,190
Cotton											
Area Planted (ha)	3,296	4,312	3,787	3,082	2,506	3,067	539	588	1,212	1,218	2,361
Average Yield (Kg/ha)	936	587	434	473	454	118	371	406	494	390	466
Total Prduction (Mt)	3,084	2,532	1,643	1,459	1,137	362	200	238	598	475	1,173

Appendix 4.1 : Extent of Plant Equipment Supply & Costs **(Preliminary)**

Item	Description	Quantity	Unit Cost Euros	Value Euros
01	**Carbonisation System Comprising**	1		
1a	Kilns			
1b	Conveying System			
02	**Briquetting/Pelletising Plant comprising**	1	88,132.00	88,132.00
2a	Briquetting/Pelletising Machine			
2b	Feeding Screw			
2c	Conditioning Screw			
2d	Pellet Cooler			
2e	Non-IBR Boiler			
2f	Grinding System			
03	**Power Chipper/Cutter Comprising**	1	5,700.00	5,700.00
3a	Cutter Chipper Assemble			
3b	Feeding Conveyor			
3c	Electrical Motor 30hp with Control Panel			
04	**Mobile Chipper/Cutter without Prime Mover comprising:**	1	3,450.00	3,450.00
4a	Cutter Chipper CC 20 Assembly			
4b	Trolley fro Mounting the Cutter			
05	**Installation, commisioning & Operator Training for 10 days**	Lot	8,500.00	8,500.00
06	**Operating Spare Parts for 2500 hours of operation**		8,800.00	8,800.00
	Total			114,582.00
	Packing forwarding and sea freight			6,215.00
	Total CNF Banjul			**120,797.00**

Other Equipment

		Quantity	Unit Cost Euros	Value Euros
	Forklift Service Pickup			

Space Requirements

Building to House Plant	6m wide x 25m length x 4.5m height
Store for Storage of Finished Product	6m wide x 10m length
Open Space for Storage of raw material	

Power Requirements

Total Connected Load	350hp, 400/440V, 50Hz	260Kw

Extent of Plant Equipment Supply & Costs

Manpower Requirements

		Estimated Cost GMD/Annum
Plant Manager	1	180,000.00
Electrician	1	45,000.00
Fitter	1	45,000.00
Drivers	3	54,000.00
Ginding Station (one semi-skilled)	4	96,000.00
Press Station (semi-skilled)	2	60,000.00
Carbonising Station (one semi-skilled)	4	96,000.00
General	4	72,000.00
Material Handling (pay per tonne)	Contract labour	-
		648,000.00

Other Overhead **275,000.00**

Cost of Electricity

Installed Load (Kw)	260	
Consumption per day @ 60% installed (Kwhr)	3,744	
Number of Day annum	250	
Total annual electricity (Kwhr)	936,000	
Cost per Kwhr (GMD)	8.02	
Annual cost of Electricity (GMD)		**7,506,720.00**

ANNEX4.2

REPORT OF THE CHARCOAL SECTOR REVIEW

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND

1.1 Introduction

PREDAS is a CILSS regional program on the promotion and development of domestic and alternative energy in the Sahel. With PREDAS assistance, all CILSS countries will work towards developing and validating a Household Energy Strategy (HES).

In most CILSS countries, household energy is synonymous with biomass energy – and will be for quite some time to come. The Gambia is no exception, with 80% of the energy balance derived from biomass. Although some tough policy decisions were taken about 25 years ago, the impact has not been evaluated. Under the supervision of the Technical Working Group and the Energy Division, Office of The President, the Development Management Consultants International was engaged to review the charcoal sub-sector with the goal to identify if and how charcoal can contribute to sustainable development while at the same time preserving our precious remaining forests.

Prior to finalizing the HES for the Gambia, four complementary studies were planned to be carried out. These are:

(i) National energy consumption survey, to describe the types and quantities of energy used as well as perception toward the different forms of energy;

(ii) Charcoal sector review, to describe the current process of charcoal production and supply as well as identify barriers to improving the efficiency;

(iii) Charcoal briquetting study to identify the feasibility and the potential of a supply of charcoal briquettes made from carbonized agro-industrial residues, to replace wood charcoal; and,

(iv) Review of the experiences with community-based natural resource management.

This report presents the study findings on the Charcoal Sector Review.

1.2 Context & Background

Charcoal remains second to firewood as the largest source of energy in Gambian households. It is reasonably affordable, durable and preferred due to its smokeless combustion. Approximately 15 thousand tons of charcoal are annually consumed in The Gambia. A ban on the production of charcoal has been in place since 1981. Initially it was illegal to even use charcoal; now it cannot be produced in the Gambia, although once it is present here, it can be legally transported and used. Presently it is generally accepted that most of the charcoal comes from outside, although some illegal production in the Gambia occurs. Recently, charcoal has become more affordable mainly due to an increase in the price of other modern fuels like kerosene and bottled butane gas as a result of exchange rate fluctuations.

The imminent fear is that a significant number of households would be tempted to switch back to charcoal. The implication of this cannot be anticipated with certainty; but the two possible logical solutions are not encouraging as they come with high economic costs: the increased demand will be met through either increased illegal imports (and resulting outflow of foreign exchange) or increased local production and associated destruction of forest resources.

Charcoal is a forest product with a relatively high value; as such it would be able to contribute to local development of the communities that properly manage their forestry resources. However, this
can only be the case if the production of charcoal is sustainable – and thus also if there is no deforestation associated with this production. If this were to happen, charcoal would be a locally produced modern energy source. At the moment however, this is legally not possible.
The present study will review the charcoal sector and make recommendations on how this could contribute to sustainable development of the Gambian economy.

1.3 Objectives of the Study

The aim of this study would be to review all the aspects of the charcoal sub-sector, from production to consumption, review of regulatory framework, an impact analysis of the ban, the effectiveness of the ban as well as consider consequences of lifting the ban for legal commercial production. Consistent with this overall aim of the study, its specific objectives are as follows:

1. Describe the current supply and demand including the *Institutional*; *Legal*; *Fiscal*; and *Regulatory aspects*

2. Consumption (quantity and trends) by region

3. Supply and source by region including *Import of charcoal; and Local production of charcoal.*

4. Pricing and price build-up

5. Description of Charcoaling Techniques used

6. Identify the Effects if Charcoal were to be produced legally

7. Legal basis for the ban on charcoal production

8. Recommendations for (institutional, legal, fiscal, and regulatory aspects)

2 CURRENT SUPPLY AND DEMAND FOR CHARCOAL

2.1 Overview of the Challenges of the fuelwood Sector

The Gambia faces four serious wood energy problems:

a. the high urban demand for fuelwood, (firewood and charcoal), with its associated environmental problems, is supplied from scarce wood resources far away from the urban areas or imported;
b. the efficiencies of both wood energy production and consumption are low;
c. The Gambia's options to deal with fuel substitution are constrained by its limited available resources; and
b. Forests are still considered as common property, where every one has unconditional user right.

The first problem, the lack of wood resources, is serious because the majority of the population uses woodfuel as a primary energy source. As a result, the limited accessible wood resources are being cut at an alarming rate. This, combined with persisting drought, and rapid urbanization, makes the woodfuel situation a very serious problem. Unless action is taken immediately, degradation of scarce forestry resources will continue.

The second problem can be dealt with in a cost-effective way: the efficient use of all usable parts of the tree and the use of improved wood stoves could save substantial amounts of wood and wood energy. Similarly, charcoal production methods can be improved to raise efficiencies of the conversion process. The issue is that the charcoal cycle is unknown at the moment; this cycle has to be fully understood before any efficiency improvement programs can be proposed.

The third problem is dependence on petroleum imports. This aspect has been substantially covered by the household energy survey preceding this study.

The percentage of LPG users is higher in the urban areas. The reasons for these are the income situation, the lack of an LPG sea terminal and bulk storage facility to reduce price of the gas. The highest percentage of charcoal users as primary cooking fuel is also in the urban centers. Wood as a primary fuel is mainly used in the rural areas.

2.2 Institutional Framework of Charcoal Production and Marketing

The production and marketing organisation of charcoal takes place within the framework of the institutional arrangements for forest resources development, management and regulation. These institutional arrangements circumscribe a number of institutional functions ranging from research and development, resource mobilisation, civil administration and regulatory agencies of both central and local government institutions. The key agencies include the Department of Forestry, Customs and Excise Department, The Gambia Police Force, Office of the Commissioners, Department of Community Development, the Department of Energy and Area Councils/Municipalities. The following summarises the respective roles of these agencies in the organisation of the production, marketing and consumption of charcoal.

Department of Forestry

The Department of Forestry is one of the 5 technical departments of the Department of State for Fisheries, Natural Resources and the Environment. The department is the custodian of the Forest Policy 1995 and its implementing tools, including the Forest Act of 1998 and the Forest Legislation.

According to the mandate of the department, the forestry service is responsible of all forestry matters, including the enforcement of government regulations.

The decentralised field administration of the forestry service controls the legal movement of charcoal at divisional level and also responsible for the collection safe keeping of all revenue that accrues from the administration of the royalties. The divisional staff are also responsible for checking and stemming-down the illegal production of charcoal.

Department of Customs and Excise (DCE)

Customs & Excise is one of the revenue mobilisation agencies of the Department of State for Finance and Economic Affairs. Its responsibilities in the charcoal industry are limited to the verification and certification of imported charcoal at boarder entry points. Importers present a hand-written export permit from the neighbouring Senegalese authorities to the Gambian custom officers at entry check-points, which the latter endorse as a warranty for importation of the charcoal in The Gambia

Gambia Police Force (GPF)

The GPF is located within the Department of State for Interior and Religious Affairs. The Forest Act of 1998 mandates this agency to assist the forestry service in enforcing the policy implementing tools. Police officers are required by law to check and verify all documents accompanying commercial forest products. The GPF is also decentralised and the malpractices can be dealt with at the respective administrative level through the engagement of the court of law.

Office of the Commissioner

Office of the Commissioner falls within the Department of State for Local Government. The five Divisional Commissioners are the heads of the administrative organ of each division. They oversee the administration of the technical departments at the decentralised level. In addition, the Commissioners are also the chairpersons of the licensing committees. They therefore endorse/approve all licences and permits for the exploitation of forest products. In the same capacity, they endorse all participatory forest management agreements.

Department of Community Development (DCD)

Department of Community Development is also a technical agency of the Department of State for Local Government. This department is central in rural development issues such as capacity building, research and development and community mobilisation. DCD is principally responsible for research and development of charcoal end-use appropriate technology and the dissemination of proven ones like the various cooking stoves in use.

Energy Division

The Energy Division is located under The Office of The President and oversee the development and implementation of the national energy policy of the government. They also promote the use of energy saving devices. They have very low staff capacity and thus not at all represented in the decentralised government.

Area Councils/Municipalities

The Councils/municipalities are under the Department of State for Local Government. They are the organs responsible for the development of the decentralised local government structure. The 2002 Local Government Act has prescribed the formation of an agricultural and natural resources committee in each division, to assist the responsible technical departments in the sustainable management of natural resources. The Councils levy and collect sales tax on charcoal

2.3 Legal Framework – Evolutionary Perspective

The legal framework for the production and marketing of charcoal is subsumed in the legal framework for the administration and management of forests, which was first provided by the Forest Act 1977. This Act classified charcoal under the general term of `forest produce` in Article 2 section

(a) and provided for the exploitation of any forest produce under licence in Article 22 section (1) and the transportation of the same under permit in Article 22 section (1).

The Forest Act 1977 is repealed by the Forest Bill, 1998 which currently constitutes the legal framework for the administration and management of forests. Like its predecessor Forest Act 1977, this Bill also classified charcoal under `forest produce`. While it is however, silent on commercialisation of charcoal, it explicitly prohibits its production, section 108 sub-section (1), thus creating room for its import and illegal domestic production.

2.4 Fiscal regime

The producers and vendors of fuelwood and charcoal are required by the forest act to:

a) be in possession of a valid licence issued by an authorised forestry officer, and

b) every forest produce must be accompanied by a valid receipt and a removal permit.

The only taxes levied on charcoal are the annual licence fee and the royalty. In both cases, the directorate of forestry fixes the rates yearly. The annual license for charcoal presently set at D100.00 and D1.00 royalty fee is levied on every 50 kg bag.

2.5 The Regulatory Framework

The legal status of the charcoal industry in The Gambia since 1980 has been anything but conclusive. Although the Presidential Degree of 1980 banned the production and marketing of the commodity it did not specify any regulatory mechanism nor penalty for contravention of the ban. Three agencies are involved in regulating this ambiguity. These are the Departments of forestry and customs and excises and the Gambia policy force

Forestry Department

The Department of Forestry is the institution mandated to set the regulations on the production, transport and marketing of charcoal. The implementation of the policy is through various tools including the Forest Act of 1998. The forest regulations provide for a control mechanism on charcoal production.

Authorised forest officers issue licences, royalties and removal permits for the legal transport and vending of charcoal. For control purposes, any forest officer can perform this duty any where without a warrant. For the smooth enforcement of this control, forest officers are posted at strategic police check points as well.

Imported charcoal must be accompanied by a valid document from the country of origin and must be certified by a customs officer at the port of entry before a royalty and removal permit could be issued.

Customs & Excise Department

The custom officers at boarder posts certified through appending their signature on the accompanying documents for verification purposes. This is intended to check illegal production and marketing of charcoal within the country.

Gambia Police Force

The Forest Act empowers police officers to act in the place of forest officers where the latter are absent in the control of forest produce. The act, unlike the other regulations, allows the officers acting on forestry matters to enter and search any premises without warrant. At checkpoints, they can stop vehicles in the absence of forest officers and examine the accompanying documents.

3. CONSUMPTION (QUANTITY AND TRENDS) BY REGION:

3.1 National consumption trends

Table 3.1 presents a detailed estimation of charcoal consumption in both physical and value terms. This detailed picture can be summarized as follows:

- Total national consumption of charcoal in physical terms is estimated at 14,716.94 metric tones;
- Out of this total national consumption, about 13,068 tones (89%) are consumed by urban households and 1649 tonnes (11%) are consumed by rural households;
- At current charcoal market prices, the total national consumption in value terms is established at D181, 399,587, representing a per/capita expenditure of D133.38;
- Of the estimated national charcoal consumption in value terms, D109.767, 251 (60.51%) was spent by urban households and D71, 632,336 (39.49%) was spent by rural households; and,

Table 3.1 Estimation of Household Charcoal Consumption

Energy Source/Variable		**Level of Estimation**		
		Urban	**Rural**	**National**
Charcoal in Tonnes	No. of Sample Household users	317	565	882
	No. of measured Households	70	136	206
	Total Daily use/measured household in tonnes	0.0006	0.00007	0.00034
	Total Annual consumption	13,067.52	1,649.42	14,716.94
Charcoal in D and TOE	Total Exp. of household buyers	10,090.5	3445	13536.50
	Total No. of days purchased by buyers	2004	1157.5	3161.50
	Average Exp. of Household buyers	33.75	18.93	28.14
	Average No. of Days use/buyer	6.70	6.22	6.52
	Total Annual Exp. of Household buyers	103,534,410.07	23,074487.07	126,608,897.14
	No. of Auto-consumer Households	18	383	401
	Imputed Exp. of Auto consumers Hhs	6,232,840.74	48,557849.17	54,790689.91
	Total Estimated TOE/annum	9,800.64	1,237.06	11,037.70*

Source: DMCI Consumption Survey – 2004.

* Conversion factors of charcoal to tones of oil equivalent is annual consumption in tones x 0.75.

- Based on the following conversion factor of tonne of wood charcoal is equal to 0.75 TOE, the total national charcoal consumption is estimated at 11,037.70 TOE comprising about 9,800.64 TOE urban and 1,237.06 TOE rural consumptions.

3.2 Regional Charcoal Consumption Trends

Table 3.2 provides a detailed analysis of the regional consumption patterns of charcoal based on data collected on the sample households in the 2004 Consumption Survey.

Table 3.2: Estimates of Regional Charcoal Consumption Trends

	% Sample Household Users		Estimated No. of Users		Average Daily Household Consumption in Tonnes		Estimated Total Daily Consumption in Tonnes		Estimated Annual Consumption in Tonnes	
	Urban	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
G BA	93.24	0.0	48322	0.0	0.0006	0.0	29.0	0.0	10585	0.0
WD	75.0	85.5	2684	338891	0.0006	0.00007	1.61	2.37	865.1	835.8
LRD	0.0	90.8	0.0	6824	0.0006	0.00007	0.0	0.48	0.0	173.4
NBD	100.0	90.4	4618	16196	0.0006	0.00007	2.77	1.13	1011.1	412.5
CRD	66.7	80.3	993	6907	0.0006	0.00007	0.59	0.48	215.4	175.2
URD	75.0	34.6	3014	3131	0.0006	0.00007	1.80	0.21	657.0	76.6
Gambia	88.0	80.788.0	59631	64545	0.0006	0.00007	34.07	4.5	13,333.7	1673.5

Source: DMCI Consumption Survey – 2004

The following depicts the regional consumption patterns in descending order of importance:

- **The Greater Banjul Area (GBA) is largest regional consumer accounting for about 70.5% of the national consumption;**

- **The Western Division comes 2nd to GBA with 11.3% of total national consumption;**

- **The North Bank Division comes 3rd with 9.5% of the national consumption;**

- **The Upper River Division comes 4th with 4.9% of the national consumption;**

- **The Central River Division comes 5th with 2.6% of national consumption; and,**

- **The Lower River Division is the least consumer with 1.2% of national consumption.**

4. SUPPLY AND SOURCE BY REGION

4.1 Local production of charcoal

The production of charcoal is banned in The Gambia since 1980; therefore no official record exists concerning the production and the location sites. However, during a field trip in Kombo East, Western Division a good number of earth kilns or old removed kilns were found almost everywhere. This indicates that illegal charcoal burning exists in the Gambia, mainly in Western Division accounting for about 80% of the commercial producers.

Table 4.1 Local Production and Supply of Charcoal by Region

Region	Urban			Rural		
	Commercial Producers	**Producer/Retail Vendor**	**Auto Producers**	**Commercial Producers**	**Producer/Retail Vendor**	**Auto Producers**
GBA	4	42	2	0	0	0
WD	2	10	0	24	12	71
LRD	0	0	0	3	6	47
NBD	0	0	2	0	0	94
CRD	0	1	2	2	0	96
URD	0	1	1	1	2	20
TOTAL	6	54	7	30	20	330

Source: DMCI Consumption Survey – 2004

4.2 Charcoal importation

Import trade in charcoal is wholly between Senegal and The Gambia, specifically Southern Senegal, Cassamance region. In this region the production is not at all in accordance with the principles of sustainability due to the rebel activity in the area. Therefore, professional forestry cannot be practiced as foresters have no access. The production is controlled mainly by representatives of the rebels. **Table 4.2** presents the monthly importation figures of charcoal for 2004 , the only available records since the ban. The total annual charcoal importation works out to something like 1971 tonnes representing about 13.13% of the annual consumption.

This is a gross under-statement of the anecdotal estimate of about 60% of total fuelwood consumption arising from imports from Senegal. It may, on the contrary, be the case that much of the market flows are in fact coming from illegal domestic production since only imports through established customs post are monitored and recorded or in fact a huge volume of imports get into the country without going through the tax system and certify the internal market spot checks with fake import certificates which may not be distinguishable from authentic hand written certificates.

4.3 Organisation of transportation

Charcoal transport reason should be considered in at least two stages, namely from the kiln in the bush to the roadside and from the roadside to the market centre. There could be also transit storage in the boarder villages.

The transports frequently used from the burning site in the bush to the roadside are donkey carts. The hiring of the donkey cart is undertaken through personal negotiations between the two. Similarly, the charcoal on the roadside is transported on any passing-by taxi and the fare is negotiable.

Table 4.2: Importation of Charcoal in Physical and Value Terms for 2004.

Month	Imports		
	No. of 50kg Bags	**Tonnes**	**Value in Dalasis**
January	7826	147.13	704,340
February	2220	41.74	199,800
March	4,933	92.74	443,970
April	9240	173.71	830,334
May	6362	119.61	578,622
June	11,896	223.64	1,070,640
July	10,864	204.24	977,760
August	10,580	198.90	952,200
September	9,154	172.09	823,860
November	7,297	137.18	656,73o
October	12,611	237.o8	I,134,990
December	11,883	223.40	1,069,470
Total	104,866	1971.46	9,442,716

Source: Forestry Department Records

Vending from house to house is mainly done by women with head loads sold by the cup. Itinerant wholesale vendors are also common and usually deploy donkey-carts as means of transport from house to house.

5. PRICING AND PRICE BUILD-UP

The use of charcoal for ironing, brewing attaya and for cooking is widespread throughout the country. The use is heavier in the urban centres even for cooking due to preference of some positive attributes, like its decency, price and availability. However, one of the most important determinants of supply of charcoal observed is the price structure.

5.1 Pricing Structure

The prices of charcoal various from region to region and it is not uniform. It ranges from D55.00/50 kg bag in the rural areas to D80.00/50 kg bag in the urban centres. At production site in the neighbouring Senegal, the vendors reported buying a filled 50 kg bag for D50.00 as at November, 2004. There are always rooms for negotiating the price, in particular for customers buying more than a filled bag or two.

There is no formal method of price build-up in the industry, as the entrepreneurs are not organised in any structure. The increase, rarely decrease, in price is determine mainly by the cost at production site, the quantity in the market and the season. However, the variation in price increase is very small and lies between D5 – D10 per period.

5.2 Price Build-up

Both at production and at marketing sites no data is available for charcoal, unlike firewood. Only an attempt can be made to build the price structure from information available through interviews at site, presented herewith in **Table 5.1.** A very quick review of **Table 5.1** reveals that the greater part of the charcoal price arises from cost of labour in making charcoal and retail margins.

Table 5.1: Price and Pricing Structure of Charcoal per cent kilo Bag

No	Cost item	Local produced (D)	Imported (D)
1	Cost of wood/stumpage fee	25	18
2	Licences	100/producer/year	
3	Royalties	1/bag	5
4	Cost of making charcoal (labour)	36	19
5	Cost of empty (50 kg container)	5	5
6	Transport		
	- Ox-Cart/Pick-up	2	3
	- Consumption centre	5	8
7	Other official/incidental cost	5	2
8	Price		
	- Wholesale price	80	80
	- Retail margin	10	
	- Retail price	90	
	- Retail margin		

Source: Forestry Department Records

6. DESCRIPTION OF CHARCOALING TECHNIQUES USED

The technique of producing charcoal in The Gambia is still the traditional earth kiln method.
There are two variances of the traditional earth kiln. The difference in the two variances is a matter of size as to whether the production is intended for household subsistence need or for commercial purpose. **Figure 6.1** and **6.1** show respectively the two variances of subsistence production kiln and commercial production kiln.

Figure 6.1: Traditional Earth Kiln for Subsistence Charcoal Production

Source: Forestry Department Records

The procedure involved in both cases is basically similar and consists as follows. The bigger logs are first lined and the small woods and /or branch-woods are placed on top. This is then covered by thin layer of earth between 2 cm to 5 cm, depending on the size of the kiln. Aeration in-lets are established directly at ground level, whose amount and distance apart depends on the size of the kiln. Earth kilns require frequent routine check-ups to make sure that there are no leakages. A Leakage of the kiln accelerates the combustion resulting in quick reduction of wood to ash and thus loss in production. The production with this earth kilns requires the use of basic and simple tools which are shovel, rake and axe. After the combustion, the ready charcoal is filled into 50kg bags.

Traditionally, it is the Fulani ethnic groups who are producers. Producers at the time of the ban and the illegal producers today are mixture of ethnic groups, who are driven to the profession mainly by low yield of agricultural products, the drought and poverty. They are not formally or informally organised into groups or associations.

According to estimations, the production from such kiln lies between 24% to 36% exploitation rates. This exploitation rate is considered a waste of wood and thus not profitable. Considering that the producers are not buying the wood for production, they do not realise the economic loss. The wood is thus still considered as a free commodity.

Figure 6.2: Traditional Earth Kiln for Commercial Charcoal Production

Source: Forestry Department Records

7. THE EFFECTS IF CHARCOAL WERE TO BE PRODUCED LEGALLY

7.1 Benefit of charcoal to the Gambian economy

The common national statistical indicators do not portray the totality of the forestry sector's contribution to the national economy. Considering the huge volume of informal trade involving forest products, it is certain that official figures seriously underestimate the sector's performance in economic terms, moreover charcoal trade is not recorded at all.

There has been a substantial increase in the commercialization of charcoal in the last six years. Noteworthy is the portion of the population seen daily in charcoal market, in particular the female folk in the periphery of urban centres, which form the majority. Those women engaged in the charcoal marketing obtain their daily living and the requirements of their children from the business. It is from the earnings where the clothing, school fees and uniforms are purchased. Therefore, the charcoal marketing contributes immensely to individuals and household incomes.

Many factors are behind this phenomenon, chief among which are the economic down turn of the agricultural sector, lack of alternatives, the favourable conditions of illegal importation from Southern Senegal due to the rebellion, and the rapid urbanization. With the recent drop in groundnut production due to negative market and climatic conditions, many rural households have shifted to the marketing of forest products including charcoal to supplement family income. Urbanisation on the other hand creates an insatiable demand for forest products, firewood and charcoal. The rebellion in the Southern Senegal, Cassamance region, does not allow sustainable exploitation of forests, and thus the importation of charcoal is more illegal.

7.2 Benefit of charcoal to the community

Charcoal production is very concentrated in Kombo East and Kombo South, the peripheral and international boarder settlements of the urban centre. These communities were farmers who have been obliged to change their occupation mainly due to urbanisation, left them with very little land, for cultivation. Many of these rural households have now shifted to the marketing of forest products including charcoal to supplement family income. It is from the earnings where the household subsistence is maintained including feeding, clothing, school fees and uniforms. Therefore, the charcoal marketing contributes immensely to individuals and household incomes.

Although there has been no direct assessment of the impact of community – based forest management on poverty alleviation, there is certainly no doubt that the implementation of participatory forest management has a positive impact on rural poverty. The areas indulged in charcoal production are mostly those not involved in participatory forest management. This is due to either lack of land or lack of the will for sustainable forest management that does not favour individual interest. As the participative forest management process opens opportunities for the communities to carry out controlled commercial activities, specified in their forest management plans, but not individuals.

7.3 Impact of charcoal on the environment

The Gambian forests are highly degraded and very composing of mainly isolated trees and shrubs, except in some forests under one form of the sustainable management. It is through human activities; mainly from the expansion of agricultural production in the late 70s/early 80s and the rampant uncontrolled forest exploitation that resulted in the presented degraded conditions of the forest cover. The ban on charcoal is therefore among the last resort to save the remaining forests.

The earth kiln can burn any kind of wood and any species. In The Gambia the producers use both wet and dry wood, and also the whole tree excluding the leaves. This can lead to complete deforestation and massive transformation and export of green manure from the forest. The combustion of wood reduces the valuable wood into ash and also contributes to the export of carbon monoxide to the atmosphere, resulting into reactions that promote global warming. Global warming affects all spheres of life and livelihood.

8. LEGAL BASIS FOR THE BAN ON CHARCOAL PRODUCTION

8.1 The Banjul Declaration

National concern with the high trend of deforestation and the need for tree planting and the rational utilisation of forest resources was prompted by the 1972/73 major Sahelian drought. Coherent public policy actions to deal with its impact on the natural resource base commenced with the proclamation of the ***Banjul Declaration*** and the enactment of the Wildlife Conservation and Forestry Acts in 1977.

8.2 Presidential Decree of 1980 of banning Charcoal

Considering the various effects of charcoal burning and the conditions of the Gambian forests, a ban on the production was pronounced in 1980 by the then President of The Gambia. The Presidential degree of 1980 has banned the production of charcoal in The Gambia mainly due to:

1. the poor and degraded forest conditions, though the total forest cover remains almost the same,
2. the lost of carbon due to combustion, and
3. to implement the Banjul Declaration of 1977.

8.3 Forest Act 1998

A high percentage of the population still depends on wood products as source of energy. Presently, only fuelwood is fairly legally produced while charcoal production is illegal. The Forest Act of 1998 prohibits the production of fuelwood in sub-section 1 of section 108. However, the act is silent on the transport and vending.

The Acts are all silent on the use of both fuelwood and charcoal transportation, only that they most be escorted with a valid licence and a removal permit. Removal permit is issued to allow transport of forest products within the country of legally produced or possessed forest products and it has no cost attached. It can however, be issued only on the face of a valid licence or permit

9. RECOMMENDATIONS

9.1 **Improving the efficiency of supply**

Charcoal is a lucrative energy source mainly for cooking in the urban areas and the only energy source used for ironing and brewing Attaya in both urban and rural areas in The Gambia. The use of charcoal for cooking is attributed to lack of smoke, its cleanliness and its comparative price. Therefore, the common people will favour the production and the traffic of charcoal in the country, despite the various impacts to the forest and the environment.

The recommendations for the setting up of charcoal briquetting plant are intended to promote the latter as a substitute. The implementation of this recommendation of this recommendation will be supported by various policy instruments including total ban on charcoal production and importation. Thus **we wish to recommend that wood charcoal production and importation be banned by the beginning of the second year of operation of the Briquetting Plant**. Consequently recommendation for improving the efficiency of supply of wood charcoal has no relevance in the circumstance.

9.2 Monitoring mechanism

With the total ban on wood charcoal production and importation, the need of a rigorous monitoring mechanism becomes crucial. This will involve the existing institutional mechanisms of the regulatory framework for forest produce. These will include the Department of Forestry, Customs and Exercise Department and The Gambia Police Force to monitor and confiscate all wood charcoal as soon as its ban comes into effect. For this purpose, **We therefore wish to recommend that the government progressively increase the licence on charcoal importation by about 200% in two years and appropriately review the Forest Bill 1998 and Forest Policy to reflect this new rate**. Such a policy reform must reflect the powers of the Forestry Department and its coadjutant agencies to monitor the production and importation of wood charcoal as offensive acts.

BIBLIOGRAPHY

1. **Energy Division/ CILSS (2004):** Report of a National Household Energy Consumption Survey in The Gambia by Development Management Consultants International (DMCI) for the 8th EDF Supported Regional Programme for the Promotion of Household Energies in the Sahel (PREDAS), Banjul, The Gambia.

2. **Republic of The Gambia (1994):** Review of Traditional Energy Sector (RPTES), Country Study 1st Draft, Banjul, The Gambia

3. **The Government of The Gambia (1998):** Forest Bill, 1998