# Republic of The Gambia

# Renewable Energy Study

## Draft RE Master Plan – Module I

Energy Demand Assessment and Projection

**November 2005**

LAHMEYER INTERNATIONAL

**Bad Vilbel – Germany**

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## ANNEXES

## LIST OF SYMBOLS

Length

mm ..... millimeter

m ..... meter

km..... kilometer

Area

$cm^2$ ..... square centimeter = $10^{-4}$ $m^2$

$m^2$ ..... square meter

ha ..... hectare = $10^4$ $m^2$

$km^2$ ..... square kilometer

Volume

ml..... millilitre

l..... litre

$m^3$ ..... cubic meter

$km^3$ ..... cubic kilometer

Weight

mg ..... milligram

g ..... gram

kg..... kilogram

t ..... ton

Time

s..... second

min..... minute

h ..... hour

d ..... day

mon ..... month

a ..... year

Electric / Energy Measure

kV ..... kilovolt

kW ..... kilowatt

kWh ..... kilowatt hour

MW ..... megawatt

MWh ..... megawatt hour

GJ..... Giga Joule

GW ..... gigawatt

GWh ..... gigawatt hour

GWh/a…… gigawatt hour per year

GWh/mon ..... gigawatt hour per month

TOE ..... Tons of oil equivalent

TWh ..... terawatt hour

TWh/a ..... terawatt hour per year

MJ ..... Mega Joule

MVA ..... megavolt ampere

kVA ..... kilovolt ampere

Hz ..... hertz

Money

ct ..... Cent

EUR ..... Euro

GMD ..... Gambian Dalasi

USD ..... United States Dollar

USct ..... United States Cent

## Conversions

| | | | |
|---|---|---|---|
| 1 kV | = | kilovolt | = $10^3$ volts (V) |
| 1 kW | = | kilowatt | = $10^3$ watts (W) |
| 1 MW | = | megawatt | = $10^3$ kilowatts (kW) |
| 1 kWh | = | kilowatt-hour | = $10^3$ watt hours |
| 1 GWh | = | gigawatt-hour | = $10^6$ kilowatt hours |
| 1 km | = | kilometre | = $10^3$ meters (m) |
| 1 cm | = | centimetre | = $10^{-2}$ meters (m) |
| 1 ton | = | metric ton | = 1,000 kg |
| 1 TOE | = | tons of oil equivalent | = 11,630 kWh |

## LIST OF ABBREVIATIONS

°C ..... Degree Celsius
e ..... estimated
E ..... Energy
EIA..... Environmental Impact Assessment
EU ..... European Union
e.g. ..... for example
GBA..... Greater Banjul Area
GDP..... Gross Domestic Product
GREC ..... Gambia Renewable Energy Centre
HFO..... Heavy Fuel Oil
IPP..... Independent Power Producer
i.e..... that is
KMC ..... Kanifing Municipal Council
LI ..... Lahmeyer International GmbH (Bad Vilbel, Germany)
LGA ..... Local Government Area
LPG ..... Liquefied Petroleum Gas
LV ..... Low Voltage
max. ..... Maximum
MDG ..... Millenium Development Goal
MV ..... Medium Voltage
min. ..... Minimum
Mio..... Million
NAWEC ..... National Water and Electricity Corporation
NGO ..... Non-Governmental Organisation
O&M ..... Operation and Maintenance
% ..... Percent
PV..... Photovoltaic
PRSP..... Poverty Reduction Strategy Paper
T ..... Thousand
TL ..... Transmission Line
TOR..... Terms of Reference
TPP ..... Thermal Power Plant
UK ..... United Kingdom
URD..... Upper River Division
V ..... Volume

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# 1 INTRODUCTION

## 1.1 AUTHORISATION

On 09 July 2004, the two parties

(1) the Energy Division Office of the President of the Republic of the Gambia, as Client, and

(2) Lahmeyer International GmbH (LI), as Consultant

concluded a contract for the preparation of a Renewable Energy Study for the Republic of the Gambia.

By this contract, Lahmeyer International is entrusted to review studies and projects already undertaken on renewable energy, analyse data available with relevant governmental and non-governmental organisations on site investigations.

The Renewable Energy Study is undertaken in two phases and comprises a range of expert studies and corresponding reports, one of which is the report in hand “Energy Demand Assessment and Projection”. Objectives and scope of this report are described in the following section 1.2.

## 1.2 OBJECTIVES AND SCOPE

Being part of the first executed phase of the project, this report is a detailed analysis of the energy demand in the country. By the means of an appropriate method, it comprises the Gambia’s energy demand assessment per customer group (residential, agricultural, industrial etc.) and per energy source (e.g. primary energy sources such as fuelwood, and secondary energy sources such as electricity). The rate of use for each energy source will be discussed (i.e. seasonal, month of the year etc.). Furthermore the study comprises an updated demand assessment for the electricity consumption of grid-connected consumers, based on data provided by the national utility.

Based on the above mentioned data and investigations, this part of the Renewable Energy Study delivers energy demand projections per type and consumer category. The forecast indicates the power demand for electricity and all major primary energy sources applied in the Gambia.

According to the Terms of Reference, the forecast is prepared in sufficient depth which allows matching of demand to renewable supplies of energy. The horizon for the energy projections is 2025 and it is presented by the means of tables and diagrams. The evolution of the projections in reference to the applied demographic and economic scenarios is thus easily comprehensible.

The assessment in this report provide the base for the investigation of possible alternatives to the current energy consumption structure, in order to achieve economic gains in terms of poverty reduction, sustainable development and efficient allocation.

## 1.3 FUNDAMENTAL DEFINITIONS FOR THIS REPORT

(1) *Demand Forecast:* It is an essential prerequisite for the utility's development planning, in particular for system expansion planning. Thereby it must be considered*: If projected demand levels are too low*, serious adverse economic consequences for consumers and the economy at large could occur; *If projected demand levels are too high*, excess resources can impose undue financial hardships on the utility and its consumers. In addition, this situation results in unnecessary and high economic opportunity costs associated with resource misallocation.

(2) *Electricity Demand at Sent-out Level*: The rate at which electric energy is delivered to a system (or part of a system). The electricity demand at sent-out level includes technical losses, non-technical losses, self consumption, suppressed demand and the final electricity demand.

*(3) Installed Capacity:* The sum of the capacities and the power plant ex generator.

(4) *Technical Losses:* Electric energy or capacity that is wasted in the normal operation of a power system. Some kilowatt-hours are lost in the form of waste heat in electrical apparatuses such as substation conductors. *Line losses* are kilowatt-hours lost in transmission and distribution lines under certain conditions.

(5) *Final Energy Demand*: The final energy demand is the demand at customer side, which actually can be measured and billed by the utility / supply company. It is equal to the sum of energy demand of each customer, customer group or sector. For analysis and projections, the final demand shall be divided into the following main sectors. Residential Customers. Commercial Customers, Institutional Customers, Industry and Agriculture Customers.

(6) *Non-Technical Losses:* Commercial losses which can occur due to power stealing by "customers", malfunctioning of energy meters, incorrect data evaluation or statistics.

(7) *Base and Peak Load:* The base load is the minimum amount of electric power required over a given period of time at a constant rate. Within a daily / weekly or monthly load pattern, this is the level of demand, that is seen as a minimum on most hours, including evenings, thereby forming the "base" on which peaks the rest.

(8) *Load Factor*: A percentage telling the difference between the amount of electricity a consumer used during a given time span and the amount that would have been used if the usage would have stayed at the consumer's highest demand level during whole time.

(9) *Suppressed Demand*: The suppressed demand is the present or expected amount of energy curtailment per year due to demand exceeding available capacity. Factors resulting in suppressed demand are unreliable generation; load shedding or an insufficiently developed network.

# 2 GENERAL

For the assessment of the current demand of the Gambia and its future projections, historical data has been analysed in several ways as well as undocumented data has been collected or estimated. This information was analysed in regard to several relevant fields and in different categories.

Chapter 3 of this report will comprise the assessment of the Gambia's demography by harnessing the latest available data in this context. This report provides thus an overview on the population of the Gambia and its development, which is going to be broken down into the country's legal and administrative entities, the Local Government Areas (LGAs). In this context, the household numbers and sizes will be examined, as they will be an important indicator for the energy demand forecast of the Gambia.

Chapter 4 of this report will provide a detailed analysis of the Gambian economy. It constitutes of the three main sectors agriculture, industry and service, whose development will be presented in comparison, but also as a break-down into sub-sectors of the respective branches.

A thorough assessment of the Gambia's Energy Consumption will be undertaken in Chapter 5. First of all, the primary energy sources (i.e. fuelwood and several oil products) which are utilised in the present and the past in the country will be presented. Furthermore, the historical development and the current situation of the use these sources will be discussed for the consumer sector such as the residential, industrial, commercial, institutional and agricultural sector and a split-up of the national energy balance will be provided. This chapter will also provide the seasonal dependence of the different energy source's requirements

Whereas Chapter 5 concentrates exclusively on the primary energy sources, Chapter 6 examines the Gambia's electricity sector. This analysis concentrates on the service area of the local utility NAWEC. After a presentation of the development of NAWEC's installed and available generation capacity, the consumption characteristics of its grid-connected customers will be provided in general and in detail. Besides a seasonal split-up of the consumption per sector and the determination of the suppressed demand, also future trends in electricity consumption will be projected in Chapter 6.

The use of primary and secondary energy sources as presented in the Chapters 5 and 6 will be summarised in Chapter 7. By the means of a Sankey diagram, the Gambia's energy balance along the whole supply chain will be demonstrated, considering input, throughput and output of the energy. Chapter 8 provides the projection of future energy requirements in the Gambia, and gives an insight into the methodology and assumptions applied. The forecasts indicate the power demand for electricity and all major primary energy sources within the period 2005-2025.

The consumption or demand of the different primary energy sources (such as heavy fuel oil, kerosene, jet, liquefied petroleum gas, gasoline, diesel and firewood), and furthermore of the secondary energy source (electricity) is subject of different chapters and sections within this report.

For a better understanding, the relevant characteristics of the respective energy sources are visualised in a range of charts, tables and diagrams. In order to respective coherence, a consistent colour code has been chosen throughout the whole report. The legend for the colouring in connection with the appropriate energy source is introduced in the following Table.

**Table 1: Colour scheme for the presentation of the different energy sources**

| Colour Code | Energy Source |
|---|---|
| | Heavy Fuel Oil (HFO) |
| | Kerosene/Jet |
| | Liquefied Petroleum Gas (LPG) |
| | Gasoline |
| | Diesel |
| | Firewood & other Biomass |
| | Electricity |

# 3 THE DEMOGRAPHY OF THE GAMBIA

During the preparation of this report, the Central Statistics Department of the Gambia finalised the evaluation and computation of data based on the 2003 population and housing census. Therefore, this energy demand study includes as the first assessment of its kind the newest available demographic data.

The Gambia is a small country at the southern edge of the Sahel populated by a number of ethnic groups. These groups are geographically intermixed and no areas of the country are dominated by villages of just one ethnic group. It is significant for a study on grazing land tenure that the Fula, with their transhuman pastoralist origins, are one of the major ethnic groups in the country. However, nowadays Gambian Fulas, like other ethnic groups in the country, are settled agropastoralists.

By African standards, The Gambia is densely populated with more than 120 persons per square kilometre (total surface area: 11,295 km²). Annex 1 gives an overview for the whole African continent. The Gambia as a whole is very rural and even in rural areas the population density is high. The country is dominated by the river from which it derives its name. It is a narrow strip of land paralleling the river, seldom more than forty kilometres wide. Because there are few ferry crossings and no bridges the country is effectively cut in two and movement across the land border to Senegal is generally easier than movement across the river. Fully one-fifth of Gambia's surface area is covered by the river and swamps along its banks (see following Figure 1)

**Figure 1: Satellite View on The Gambia and Neighbouring Areas of Senegal (Source: Visible Earth)**

**Table 2: Development of Population Number (1993-2003)**

| Local Government Area / District | Population 1993 [capita] | Population 2003 [capita] | Average Annual Change [a-a %] |
|---|---|---|---|
| **THE GAMBIA** | **1,038,145** | **1,360,681** | **2.8%** |
| | | | |
| BANJUL | 42,326 | 35,061 | -1.9% |
| KANIFING | 228,214 | 322,735 | 3.5% |
| BRIKAMA | 234,917 | 389,594 | 5.2% |
| MANSAKONKO | 65,146 | 72,167 | 1.0% |
| KEREWAN | 156,462 | 172,835 | 1.0% |
| KUNTAUR | 67,774 | 78,491 | 1.5% |
| JANJANBUREH | 88,247 | 107,212 | 2.0% |
| BASSE | 155,059 | 182,586 | 1.6% |

The population of the Gambia in 2003 is estimated at 1,360,681[2] from 1,038,145 in 1993. This suggests an annual population growth rate of 2.8 % down from 4.2% during the 1983 to 1993 inter-census period. At this growth rate the population doubling time is estimated at about 25 years. Different Local Government Areas experienced different population growth rates as result of internal migration. After experiencing a 63% increase in population between 1963 and 1983, the City of Banjul experienced an annual decline in population of 4.2% between 1983 and 1993 and at an estimated rate of 2.2% during the 1993 –2003 inter-census period. This decline was due to an out migration from Banjul to the suburbs in Kanifing Municipal Council area as commuting to and from Banjul became easy. Table 2 shows a comparison of population number in 1993 and 2003 for the Gambia in total, and individually for several regions, which will be explained later in more detail. Under consideration of an annual change of the overall population number by nearly 2.8% the present number of country`s inhabitants is estimated at 1,442,400 (2005).

At present about one-in-four Gambians live in the Greater Banjul Area, the region comprising the City of Banjul and Kanifing Municipal Council. The area occupies 93 km² (0.08% of the total land area). The proportion increases to 34% when we include Kombo North, the district bordering Greater Banjul Area. An estimated 789,000 live in the City of Banjul, Kanifing and Brikama Local Government Area, about 55% of the total population. The City of Banjul is the most densely populated district (approx. 3,400 persons per km²), followed by the Kanifing

[2] The provisional results of "2003 population and Housing Census" published in April 2004 by the Central Statistics Department referred a total number of 1,364,500 (percentual divergence: 2.8 ‰).

Municipal Council (approx. 3,100 persons per km²) and Kombo North (approx. 459 persons per km²). Districts with the lowest population density include Kiang West (approx. 20 persons per km²) in Lower River Division, Foni Bondali in Western Division (approx. 30 persons per km²) and Sami in Central River Division with a density of 32 persons km².

## 3.1 LEGAL AND ADMINISTRATIVE BACKING OF DEMAND ASSESSMENT

To consider the individual regional characteristics of current and future energy demand, the assessment follows the administrative classification already applied by the Central Statistics Department for census and other statistical research purposes. The country has been divided into eight Local Government Areas (LGA), each corresponding to an administrative division, municipality or capital city, except Kuntaur LGA which correspondends to the north of the Central River Division.

In the following a short cross-section is provided, which includes for each division an overview of population number and its development in recent years (according to the latest results of National Census up to 2003) .

**Table 3: Classification of Local Government Areas and Administrative Divisions**

| Local Government Areas | Administrative Division |
|---|---|
| LGA OF BANJUL | Greater Banjul Area (GBA) |
| LGA OF KANIFING | |
| LGA OF BRIKAMA | Western Division |
| LGA OF MANSAKONKO | Lower River Division |
| LGA OF KEREWAN | North Bank Division |
| LGA OF KUNTAUR | Central River Division |
| LGA OF JANJANBUREH | |
| LGA OF BASSE | Upper River Division |

The ***Greater Banjul Area*** consists of the City of Banjul (St. Mary's Island) and the agglomeration of Kanifing Municipal Council (KMC) sometimes called Kombo St. Mary Division.

Occupying an area of 88 km² (less than 1% of Gambia's land area), Greater Banjul Area is home to a population of 357,800 (26% of the country's population).

The City of Banjul is the seat of government with the State House and the National Assembly, Supreme Court and all but a few of the Government departments based there. The country's only port is in Banjul with a number of fish landing and processing facilities. Banjul's position as the largest city and the center for commerce and trade is slowly being eroded by the emergence of Serre Kunda and surrounding Kanifing Municipal Council formally Kombo St. Mary Division as most populous and commercial center in the Gambia. Banjul's population peaked in 1983 at 45,000. Since then over-crowing and establishment of public transportation system has led to people relocating to Kanifing Municipal Council. Since 1963, the population of KMC increased from less than 12,000 to 322,000 by 2003.

The ***Western Division*** is the division immediately south of Kanifing Municipal Council, stretching from Tanjeh on the Atlantic coast to Sintet in Foni Jarrol. With a population of 389,600, the Division is the most populous local government area. There are 9 districts in the Division with Kombo North the most populous. Between 1963 and 2003, the population of Western Division increased from 55,000 to over 389,600 primarily in the three districts immediately neighbouring Greater Banjul Area. The population of Kombo North the district immediately bordering KMC increased from 80,000 in 1993 to over 162,000 by 2003.

Everyday life in the country's capital
Greater Banjul Area

Everyday life
Western Division

**Figure 2: Impression of Normal Course of Life in Selected Areas**

The divisional headquarter is Brikama. With a population of 65,000, Brikama is the largest city in the Division. Other major towns in the Western Division are Lamin, Wellingara, Sukuta, Kerr Serign and newly established settlement of Brusubi housing estate. Many of these new settlements are along the Atlantic coast.

The ***Lower River Division*** with a population of 72,200 is the least populated division in the Gambia. Until late 1960s when it became its own division, North Bank Division was part of Lower River Division. With Mansakonko (king's hill or government hill in Mandinka), LRD has 6 districts with Kiang West District (KMC) the largest. Like all other divisions east of Western Division, the the division has suffered from steady out-migration of population to either Banjul, the Western Division or KMC.

Kiang West is the largest and least populated district. Jarra Central home to both Mansakonko and Soma, the economic capital of the division is the most populous district. Jarra Central has experienced rapid expansion in its population throughout the 1980s and 1990s. The rapid growth was driven in part by its role as one of the hubs on either side of the Bambatenda-Yelitanda crossing along the Trans-Gambia Highway. The Trans-Gambia Highway is the main trunk road linking Cassamance and the rest of Senegal. During the Senegambia Confederation, Jarra Central and the town of Soma in particular has seen a rapid increase in cross-border commerce and trade fueling the rapid influx of people into the area. Eight of the 10 largest settlements in the Division are in Jarra Central.

The ***North Bank Division*** occupies the western third of the north bank of the Gambia from Barra to the border with Lower Saloum in Central River with Senegal's Kaolack and Fatick regions to the north. The Upper Baddibu is the largest and most populous of the 6 districts in the Division. The headquarter is Kerewan although Farafenni is the most populous town and Barra the one with the most economic activities of the division. Until the expansion of the Ferry services to Barra and the construction of the bridge across Mini Minyang Bolon at Kerewan, the division had suffered a lot due to poor access to Banjul.

Upper Baddibu district with Farafenni as main town in the division is the largest and most populous district. The district located opposite Jarra Central along the Trans-Gambia Highway benefited from the growth in cross-border trade during the 1980s and early 1990s as a result of the Senegambia Confederation resulting in the influx of migrants from neighbouring Senegal and other districts in North Bank and Central River. However, the population of Upper Baddibu stabilised by the early 2000s after the collapse of the Confederation.

The ***Central River Division*** (formerly MacCarthy Island Division) with an area of about 3,038 km² is the largest Local Government Area in the Gambia. The division consists of 10 districts including MacCarthy Island with the headquarter in Janjanbureh (formerly Georgetown). Because of difficulties in logistics between the north and south bank, the division is sometimes considered as two Local Government Areas, with Kuntaur the de facto headquarter for the north bank and Janjanbureh the headquarter for the south bank. Formally called Lemaine Island, the island was purchased by the British Crown in 1832 and renamed MacCarthy Island after Sir Charles MacCarthy, the English governor at the time. Shortly after, a fort and a trading post were built on the Island. Up until the late 1960s, the Janjanbureh was the unofficial “upcountry capital” with the country’s only boarding school. Since independence, however, Janjanbureh has slowly lost to Bansang the status as the Division’s de facto economic capital. This was primarily due to inaccessibility to the Banjul and the rest of the country. Central River Division has 10 districts including MacCarthy Island. Fulladu West is the largest and most populous

district in the Division. With only 26% of the land area, the district is home to 39% of the total population in 2003.

With some 182,600 inhabitants (2003) the ***Upper River Division*** ranks on third place in comparison with the population number of other divisions. The Upper River Division (URD) includes the four districts Fulladu East, Kantora, Wuli and Sandu. With a population of nearly 99,000, the district Falluda East is the largest settlement in the division. It includes the Gambia's easternmost town Basse Santa Su, the capital of the Local Government Area. Basse town is a lively settlement with trading houses from the turn of the century, shops, and a riverside market. Occupying an area of 2,700 km², Upper River Division is the second largest division behind North bank (LGA of Kerewan). Population density amounts to 88 persons per km².

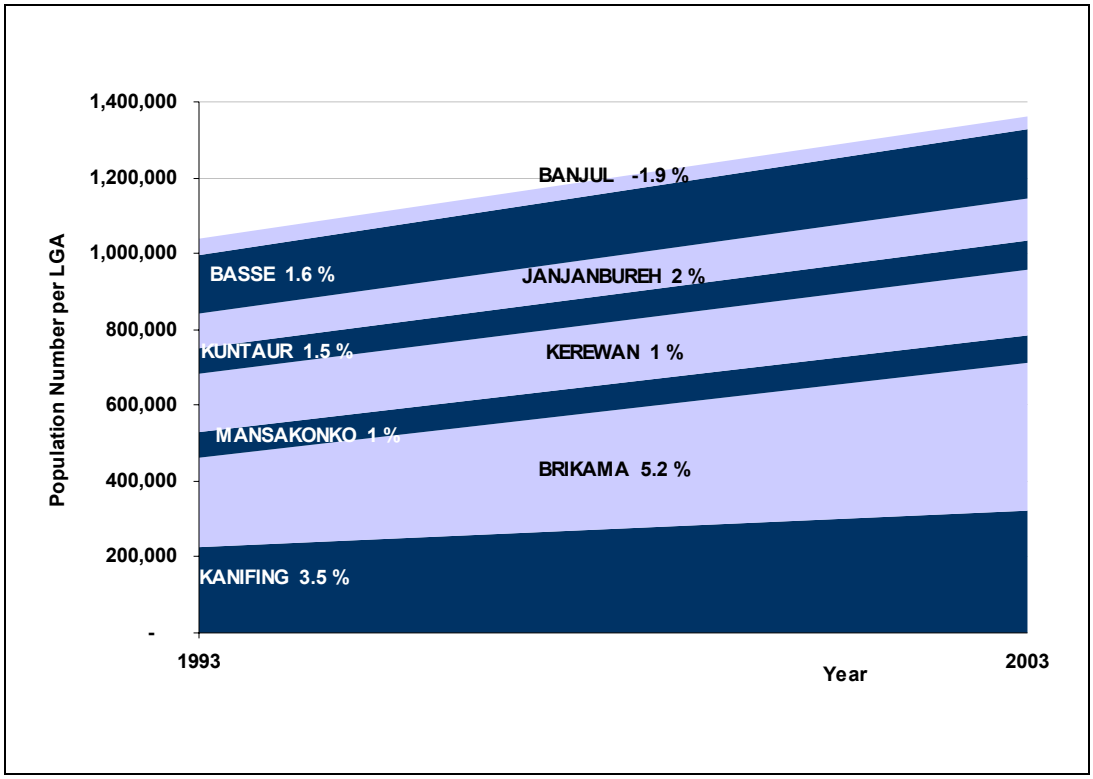



**Figure 3: Development of Population Numbers per Region (1993-2005)**

Figure 3 above illustrates the demographic development for each region described. A projection of population number was carried out based on calculated annual changes which occurred during the decade 1993-2003. The highest annual growth rate is observed for the LGA of Brikama with some 5.2% followed by Kanifing with 3.5%. Except Banjul with its already mentioned population number decrease, low annual changes are registered for the eastern parts of the Gambia. The lowest growth rates are registered for the North and Lower Bank Division, each region by only 1%. The figures underline the results of discussions with local authorities carried out by the Consultant. Beside migration from rural to urban areas, the main

migration direction in the Gambia is from east to west. In particular in the GBA neighbouring area, the LGA of Brikama people settle down due to better opportunities to take up employment. The population's economic situation will be discussed in more detail in section 3.3 Poverty Situation. Annex 2 shows in detail the demographic figures for each LGA and each single district. A comparison of 1993 and 2003 figures is included.

Finally Table 4 gives an insight in the estimated population number of the Gambia by the year 2005. These figures as well as the applied regional break down are one of the input information which will be used as base for the projection of country's future energy demand.

**Table 4: Estimated Population Number per Local Government Area (2005)**

| Local Government Area / District | Population 2005e [capita] |
|---|---|
| **THE** | **1,437,107** |
| GREATER BANJUL AREA | **379,400** |
| LGA OF BANJUL - URBAN ONLY | **33,700** |
| LGA OF KANIFING - URBAN ONLY | **345,800** |
| LGA OF BRIKAMA | **431,800** |
| LGA OF MANSAKONKO | **73,700** |
| LGA OF KEREWAN | **176,300** |
| LGA OF KUNTAUR | **81,000** |
| LGA OF JANJANBUREH | **111,400** |
| LGA OF BASSE | **188,700** |

## 3.2 HOUSEHOLD NUMBER AND AVERAGE HOUSEHOLD SIZE

Except in Banjul, all other regions experienced a rise in the number of households and hence an overall increase of the number of households from 116,001 in 1993 to 157,494 households ten years later. This showed an increase of more than 36 % in the number of households over the inter-censal period. Banjul witnessed a drop in the number of households from 7,032 in 1993 to 6,744 households in 2003 representing a percentage decline of 4.1. the largest increase in number of households was observed in Brikama LGA with a percentage increase in the number of households of 77% followed by Kanifing LGA, which also witnessed a substantial increase of nearly 58%. Apart from Banjul, which recorded a negative change, for Mansakonko LGA the lowest increase in number of households with an increase of only 3% is observed.

Changes in average household size observed have shown variations in trends with some regions experiencing a decline whilst others witnessed an increase. Predominantly urban regions of LGAs registered a decline in average household size whilst rural regions shown an increase in average household size. Increases in average household size were observed in Mansakonko, Kuntaur, Janjanbureh and Basse LGAs. The LGA of Kerewan was the only predominantly rural LGA with a decline in average household size although the decline was quite insignificant. Declines in average household size was also observed in Banjul, Kanifing and Brikama LGAs. Overall, there has been a downward trend in the average household size from 8.9 in 1993 to 8.6 in 2003. The downward trend in household size observed in urban LGAs might be attributed to a combination of factors.

The Central Statistics Department estimates that the influence of western education on attitude to family is significant among these factors. Increased education tends to negatively impact the desire for large family sizes. Another factor may be associated with the movement of a large proportion of the population from the agricultural sector to other sectors of the economy over the years, making large family sizes less attractive.

Rural housing close to Sibanor town

Urban housing, periphery of Brikama town

**Figure 4: Impressions of the Residential Sector in The Gambia**

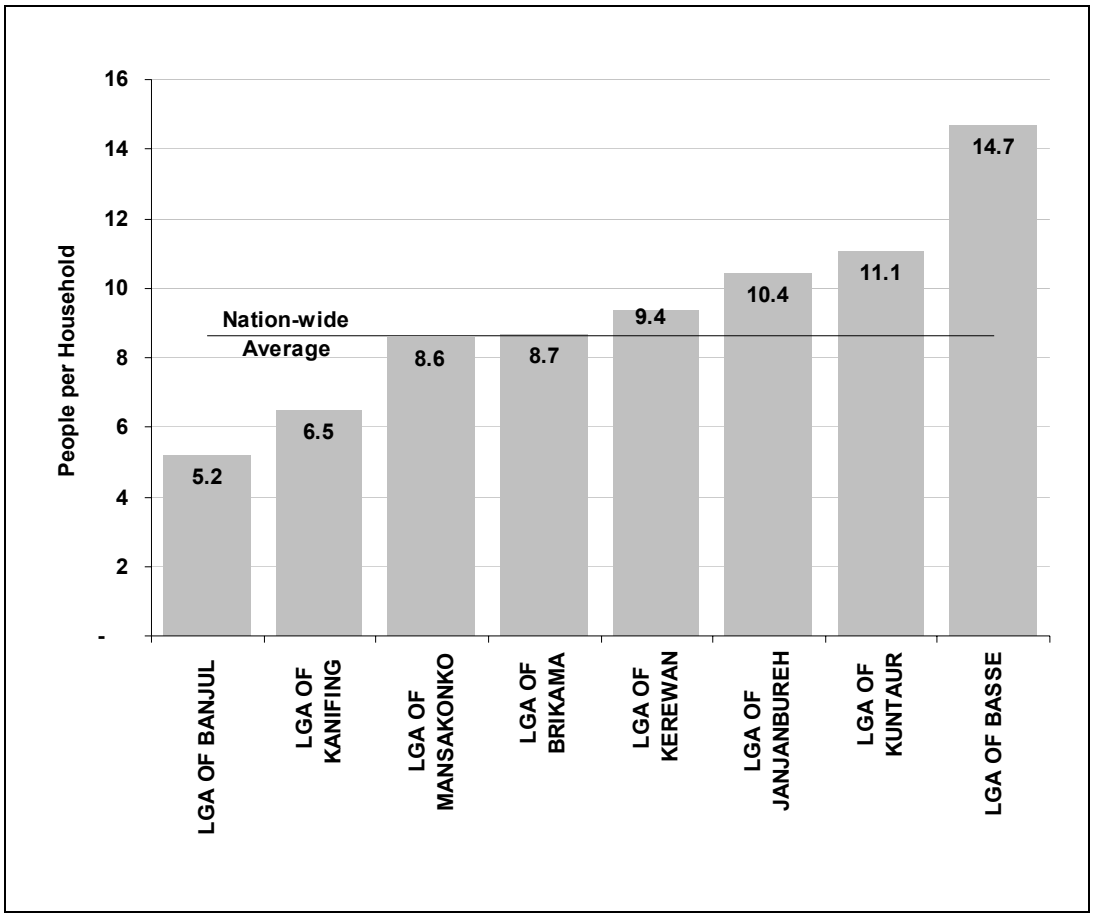



**Figure 5: Comparison of Household Sizes in Several LGA**

The above Figure 5 illustrates the average household sizes for each Local Government Area of the Gambia. Mansakonko and Brikama are those two LGAs, which are most representative for the nation-wide characteristic. In both LGAs, an average of approximately 8.6, respectively 8.7 people live in one household. With 5.2 and 6.5 people per household, the both urban areas Banjul and Kanifing are the regions with the lowest household sizes. The comparison in the figure shows that in general the household size increases from the Gambia's west to eastern LGAs. The highest value is registered in Basse, with an average of 14.7 people. This indicator is nearly three times higher than the related figure of Banjul.

## 3.3 POVERTY SITUATION

The Gambia is one of the poorest countries in Africa. In 2005, the Gambia was ranked 155$^{th}$ (out of 177) in the United Nations Development Programme-Human Development Index. The poverty line is a given level of goods and services (food and non-food) regarded as essential for a minimum standard of living. Households whose consumption fall below the poverty line are classified as poor and those above it as non-poor. In the case of the Gambia, two absolute

consumption poverty lines were established, based on estimated minimum requirements (taken as 2700 kcal per day per Adult Equivalent Unit), as follows:

- ***Food poverty line*** amounts to GMD 2,964 per equivalent adult per year. The food basket contains items that provide a healthy life at a relatively low cost taking into consideration the relative perceptions of living standards in the society.
- ***Overall poverty line*** of yearly GMD 5,539 per equivalent adult. The overall poverty line is composed of food poverty line adding an allowance of non-food requirements to guarantee a life on the subsistence level.

The Household Poverty Survey Report shows in Table 5 that there is a high increase in the overall poverty line of some 62% to 126% in 1998 compared to 1992. This increase can be traced back to the facts as follows:

- few items in the food basket were substituted by cheaper or much easier available items;
- the price data, when valuing the food consumption basket in 1998, was inappropriate;
- regular rise in the consumer price index over this period.

Poverty in the Gambia is particular more often found among women and in rural areas. Although urban areas were increasing in 1998, as a result of increasing rural-urban migration, 62% of the population fell below the overall poverty line in urban areas, compared with 80% in rural areas. Within rural areas, poverty prevalence rates with the highest levels of extreme poverty, approximately 50% have been located in the Lower and Upper River Division. Central River and North Bank Division had slightly lower rates of approximately 45%, while the Western Division had the lowest rate of approximately 20%. This is shown in Table 6.

**Table 5: Comparison of the Consumption Value in GMD/a per Adult Equivalent Unit (1992– 1999)**

| Region | Census 1992/93 | | Census 1998 | | Absolute Change from 1992 to 1998 | |
|---|---|---|---|---|---|---|
| | **Food Poverty Line** | **Overall Poverty Line** | **Food Poverty Line** | **Overall Poverty Line** | **Food Poverty Line** | **Overall Poverty Line** |
| Greater Banjul Area | 1636 | 2443 | 2964 | 5539 | 81% | 126% |
| Other Urban Areas | 1597 | 2404 | 2610 | 3898 | 63% | 62% |
| Rural Areas | 1371 | 1778 | 2576 | 3088 | 88% | 74% |

Source: NHPS Report 1998

**Table 6: Population below Poverty Line (1998)**

| Region | Extremely poor | Poor [%] | Non-Poor |
|---|---|---|---|
| The Gambia in Total | 29.7 | 17.2 | 53.1 |
| Banjul | 1.7 | 17.5 | 80.8 |
| Kaniging | 6.8 | 11.8 | 81.5 |
| Lower River | 50.5 | 13.4 | 36.1 |
| Central River | 43.3 | 11.7 | 45 |
| North Bank | 45.9 | 20.9 | 33.2 |
| Upper River | 49.2 | 16.1 | 34.8 |
| Western | 20.2 | 24.5 | 55.2 |

Source: NHPS Report 1998

A characteristic feature poor households is household size. While a large number of non-poor households consists of less than 5 members, only 10% of extremely poor and 20% of poor households are of this size. Rather poor households have an average of 6 to 10 family members, whereas these households‘ incomes are below the food and non-food poverty lines.

Table 7 shows the distribution of income divided into quintiles and grouped in categories of the Gambia's population. As can be seen, households in the highest income quintile have incomes 13.8 times that of the lowest one. The average expenditure of consumption amounts to GDM 9,690 in Greater Banjul, which is greater than the Gambia’s that amounts to GDM 5,926. In comparison with The Gambia’s average consumption expenditure the Other Urban one’s spend GDM 4,927 and in rural area GDM 3,038 on consumption.

**Table 7: Comparison of the Consumption Value in GMD per Year per Adult Equivalent Unit**

| Region | 1st Quintile | 2nd Quintile | 3rd Quintile | 4th Quintile | 5th Quintile | Mean expenditure per adult aquality |
|---|---|---|---|---|---|---|
| The Gambia in Total | 1189 | 2262 | 3579 | 6004 | 16611 | 5926 |
| Greater Banjul Area | 1413 | 2322 | 3644 | 6102 | 17395 | 9690 |
| Other Urban Areas | 1422 | 2201 | 3695 | 5910 | 12395 | 4927 |
| Rural Areas | 1156 | 2256 | 3488 | 5790 | 14618 | 3038 |

Source: NHPS Report 1998

To show the income distribution in detail, the average income for households varies in administrative divisions. The highest average income can be earned in Kanifing and Banjul, whereby the lowest average income is paid in the Lower River division. Figure 6 represents the

average incomes by division in GDM per year per Adult Equality Unit compared to the Gambia's average income which is shown as line.

Table 6 shows that most of the households living below the poverty line are located in Lower River, Central River, North River and Upper River Division. Relying on the rural characteristic of this area, traditional biomass fuels such as fuelwood, crop residues, and dung are used as energy source for cooking and heating. Figure 7 illustrates that countries with very high poverty are highly dependent on traditional energy, while countries with poverty levels less than 50% are distinctly clustered into two groups of low traditional energy dependence and high traditional energy dependence. The Gambia (located with the data (47; 99) belongs to the second group, which is highlighted in black.

Further, a negative relationship exists between access to electricity and proportion of population below poverty. Only 20% of the 47% of population that live below the poverty line have access to electricity: This is shown in Figure 8 where the Gambia's position is highlighted in black. However, the relationship between poverty and access to electricity in the benchmarked PRSP countries is less robust because electrification is influenced by several supply-side factors, lag effects of energy infrastructure, limited grid connectivity, poor distribution system, and unrecorded connections.

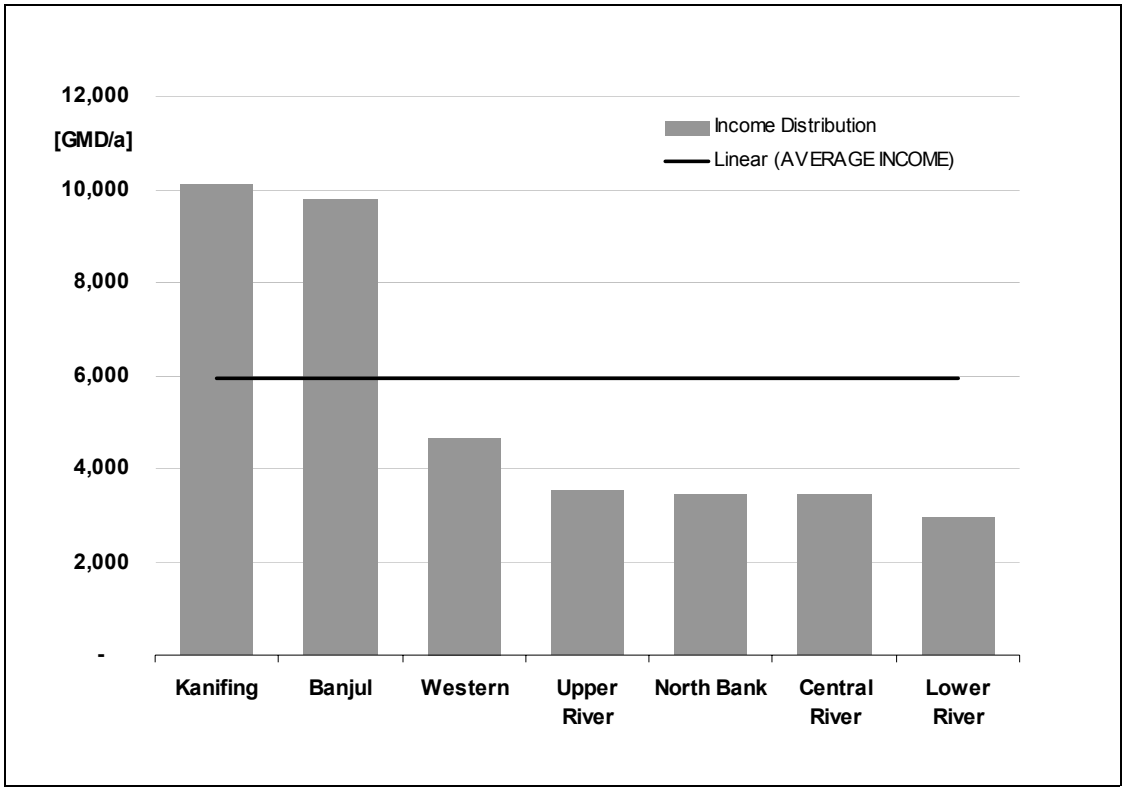
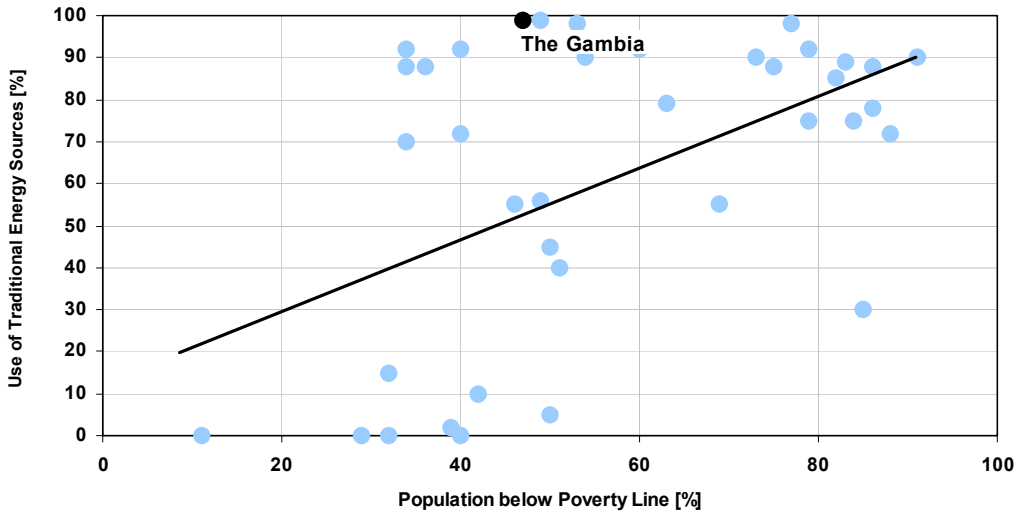
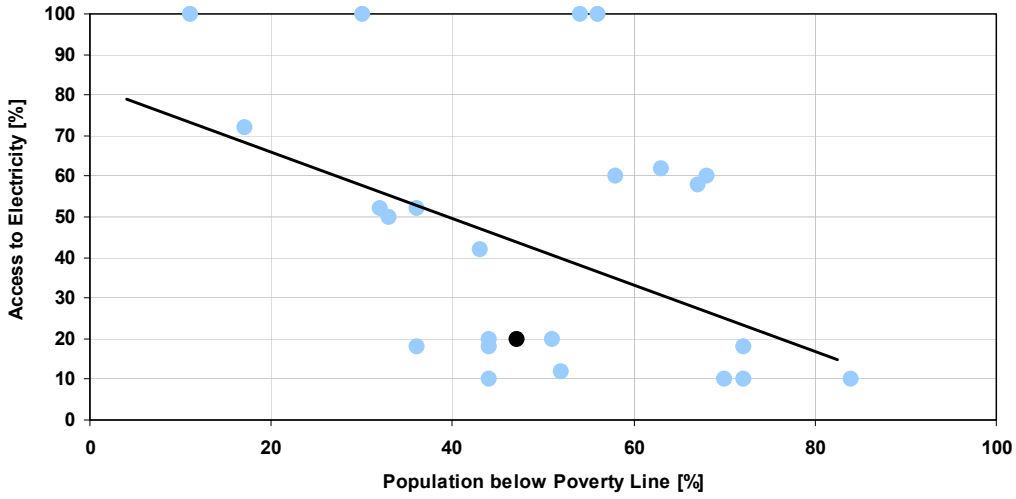



**Figure 6: Income Distribution of Households by Division (1998)**




Source: PRS and the MDG Environmental Sustainability 2003

**Figure 7: Poverty Incidence and Traditional Energy Dependence in PRSP Countries**




Source: PRS and the MDG Environmental Sustainability 2003

**Figure 8: Poverty Incidence and Access to Electricity in PRSP Countries**

# 4 THE ECONOMY OF THE GAMBIA

The Gambia has a liberal, market-based economy characterised by traditional subsistence agriculture, a historic reliance on groundnuts (peanuts) for export earnings, a re-export trade built up around its ocean port, low import duties, minimal administrative procedures, a fluctuating exchange rate with no exchange controls, and a significant tourism industry.

## 4.1 PRESENT CONDITIONS

***Agriculture*** accounts for 28.7% of the gross domestic product (GDP) and employs 75% of the labour force. The agricultural sector is dominated by the production of groundnuts that contributes alone to 49% of the GDP proportion due to crop production. These figures underscore the predominant position that groundnut production (and in addition groundnut exports) occupy in the Gambian economy. They also bring out another significant feature of the economy, namely its openness. This is further manifested by the vulnerability of the economy to fluctuations caused by unexpected changes in groundnut production and in world prices for groundnuts and their products.

Other food crops feature in the agricultural sector as well, the major ones being rice, millet, sorghum and maize. Rice is cultivated mainly in upriver swamps along the Gambia River. Although cotton was introduced in the 19th century, efforts to increase the area -

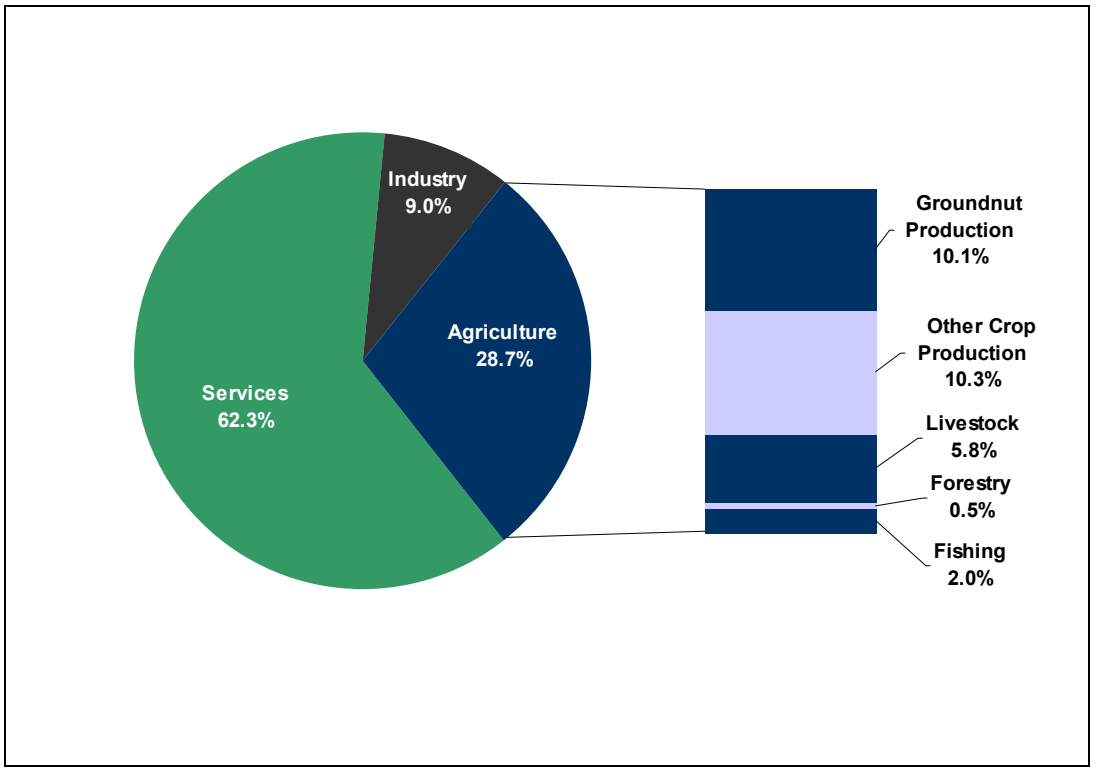



**Figure 9: Contribution to GDP by Economic Activity – Focus: Agriculture (2003)**

under cultivation to a significant degree have not yet been successful, and hence cotton production represents a very small proportion of agricultural output. Other important sub-sectors of the agricultural sector are livestock and fisheries. Here again, although both have vast potential, it is by no means fully exploited. Livestock and fisheries together account for only 5.8% or 2.0 % respectively of the Gambia's GDP. The smallest proportion is contributed by the forestry sub-sector by 0.5% of the total. Figure 9 provides a detailed insight into the composition of the agriculture sector and the proportion of GDP output for each individual sub-sector.

The ***Industrial sector*** is very small in Gambia, and its contribution to GDP is estimated to be only 9%. The large and medium scale manufacturing sector[3] provide an output of only 2.3%, small scale manufacturers some 1.2%. The limited amount of manufacturing is primarily agriculturally based (e.g., peanut processing, bakeries, a brewery, and a tannery). Other manufacturing activities include soap, soft drinks, and clothing.

As shown in Figure 10, also the mining and quarrying sector plays no significant role in GDP contribution with only 0.6%. The estimated reserves of recoverable minerals yield a conservative total of about 995,000 tonnes at a 1% cut-off grade. Further investigations will be conducted to update the reserve base of these minerals. The following minerals have been identified in The Gambia following some mineral exploration programmes

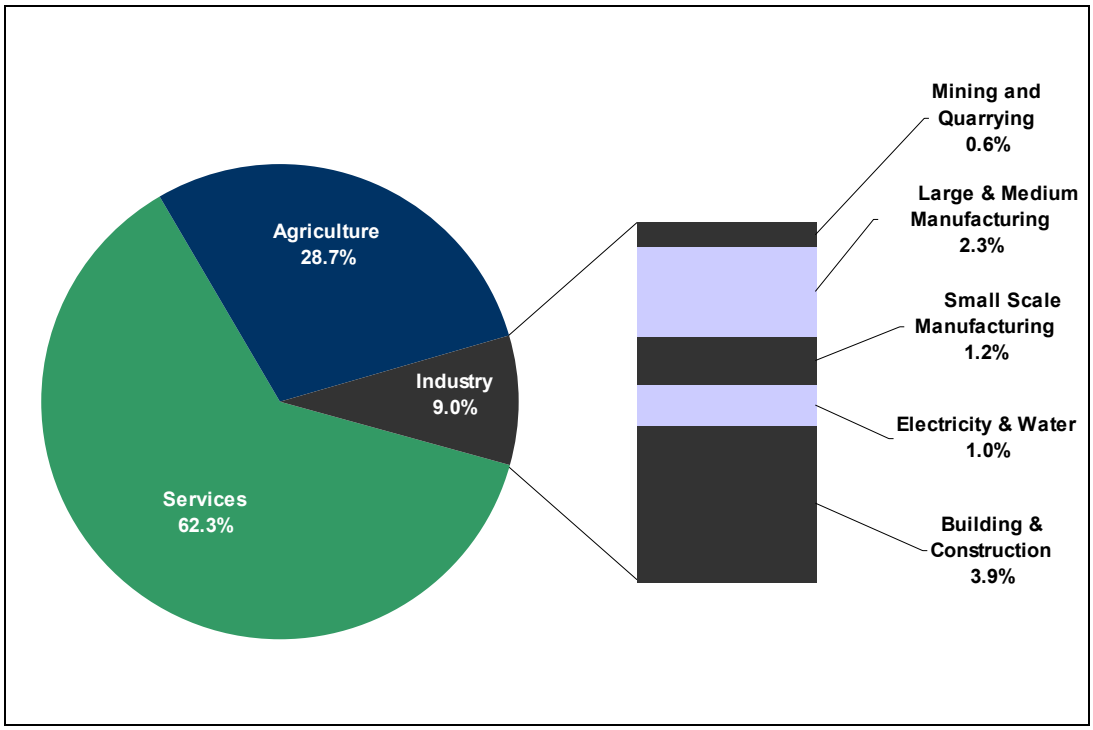



**Figure 10: Contribution to GDP by Economic Activity – Focus: Industry (2003)**

conducted with the lead participation of the Geological Department.

[3] Medium and large scale manufacturing includes more than 4 workers per facility.

- Quartz Sand - large reserves of quartz sand, suitable for glass manufacture, have been identified in the Greater Banjul Area, and also notably in Abuko, Brufut, Darsilami (Western Division); Mbankam and Bakendik (North Bank Division); and Kaiaf, (Lower River Division). The Government continues to seek interested investors to exploit these deposits.

- Heavy Mineral Beach Sand Deposits - the raised beach sand, which is characteristic of The Gambia's coastal beaches, contain ilmenite, rutile, and zircon. The deposits were briefly mined in the past and recently the Government is keen in attracting interested investors in exploiting the deposits.

The ***service sector*** occupies an important position in the economy of the Gambia. It contributes nearly two thirds of the GDP. As Figure 11 illustrates, the major sub-sectors are trade and transport. Foreign trade plays a vital albeit diminishing role in The Gambia's economy development. Its contribution to GDP amounts to 26.3% in 2003. The UK and other EU countries constitute The Gambia's major domestic export markets, accounting for more than 80% in total; followed by Asia and the African subregion, including Senegal, Guinea-Bissau, and Ghana. The UK and the other EU countries – i.e. Germany, France, Netherlands, and Belgium- were the major source of imports accounting for 60% of the total share of imports followed by Asia with more than 20%, as well as the Ivory Coast and other African countries.

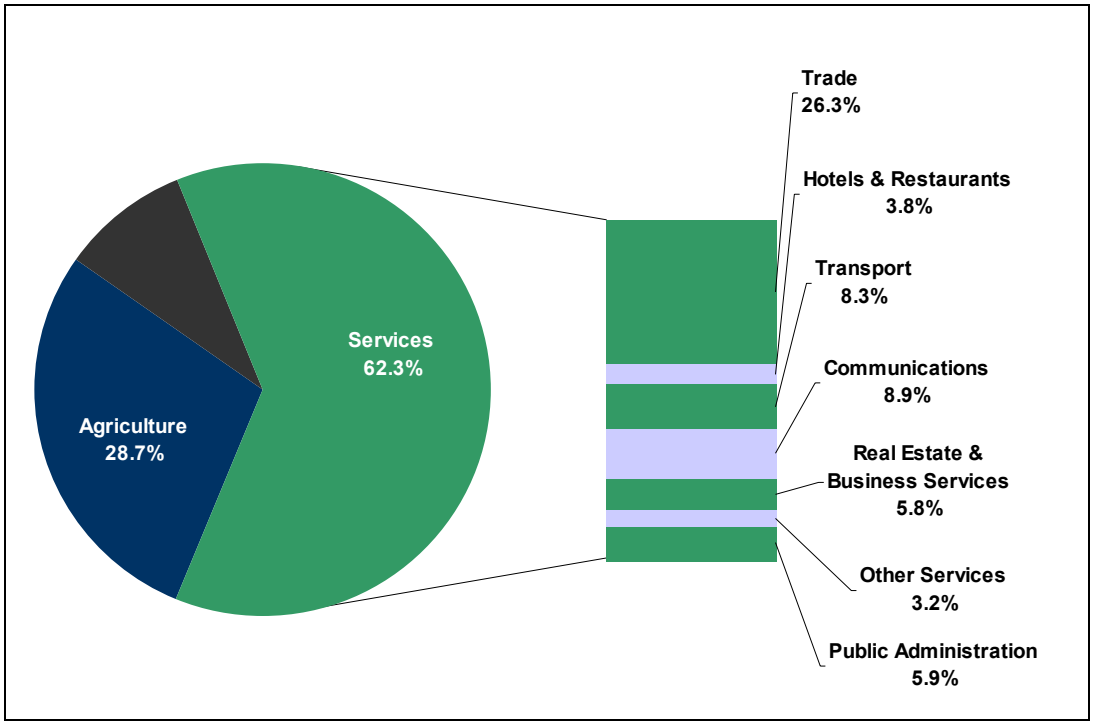



**Figure 11: Contribution to GDP by Economic Activity – Focus: Service Sector (2003)**

Small Scale manufacturing includes less than 5 workers per facility.

There are four major transport systems that play an important role in the Gambian Economy: via air, via sea, via road and via the river. Nevertheless, the present situation of the transport industry in the Gambia is rudimentary with little or no integration of transport modes and little industrial organisation, particularly for haulage transport. Financing of transport infrastructure is mainly borne by the Government with a burden on the public investment programme. Master plans have been drawn for each major mode of transportation, that is sea, land and air, but institutional arrangements for sustainable financing and accelerated inter-connection of transport modes are yet to be implemented.

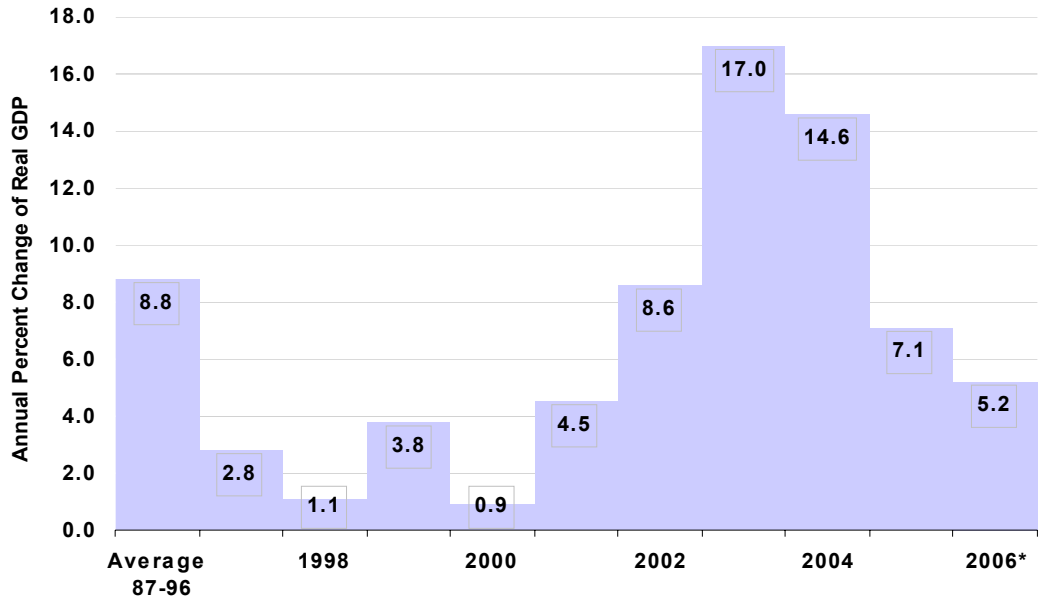
The development of transport system infrastructure is directly linked to other service sub-sectors, in particular to the tourism branch. In recent years, the Gambia as a tourist destination has stalled in its progress. Whereas tourism had grown in surges in the 1970s, 1980s and 1990s, tourist numbers have remained below 100,000 per year for a decade. The State Department for Tourism and Culture estimates a number of 16,000 employees in the Gambian tourism branch. Nevertheless, hotels and restaurants contributed to some 3.8% of the GDP in 2003. That is less than the proportion of e.g. transport, communication or public administration sub-sectors.

## 4.2 EXPECTED FUTURE DEVELOPMENT

There are a range of measures going on in order to make Gambia a higher income country. These comprise for example policy reforms, rural initiatives in education and health, as well as improvements in the service sector and shall enable the Gambia to become a higher income country. Furthermore, the Gambian government has established a liberal trade regime and has thus consolidated trade links with the EU, USA, Asian countries, and the ECOWAS sub-region. With adopting the implementation of Economic Partnership Agreements, The Gambia expands its trade links with the EU, and will be getting enhanced technical assistance by the EU, which will result in a positive impact on the Gambia's economy. Another measure is the stimulation of the private sector development by encouraging increased private sector participation, in particular in industrial production.

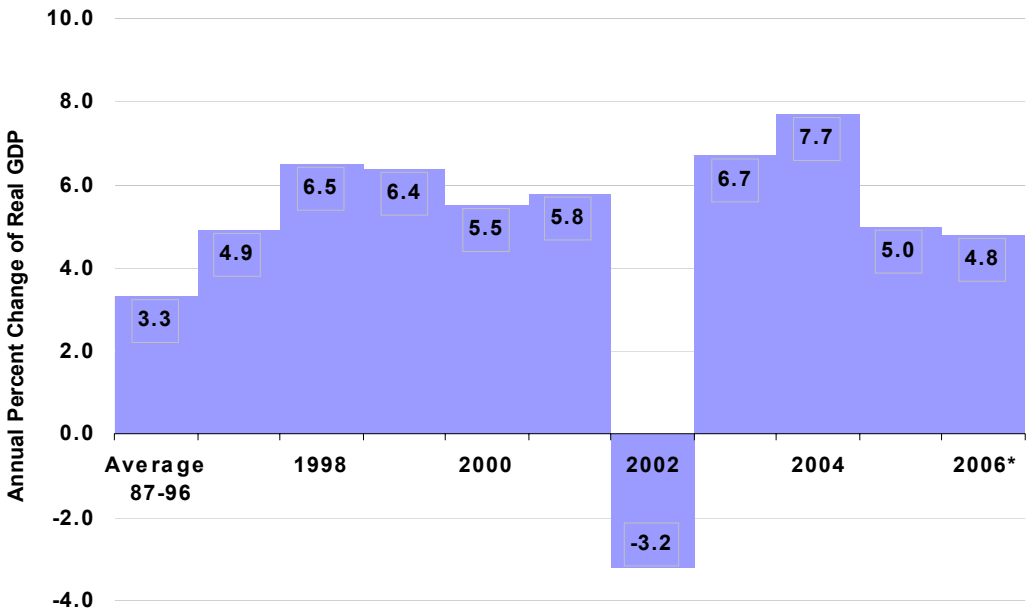
However, the three main sectors of the Gambia's economy, Agriculture, Industry and Services, which are already described in section 4.1, have certain weaknesses, but also potential which can be expanded and thus have to be stimulated in order to increase the country's economic growth as well.

The agricultural sector currently faces many problems, which comprise low farm income, growing rural poverty, household food insecurity, accelerated rural-urban drift and rapid environmental degradation. Therefore the Government's objectives are rather reticent. For the period 2005-2010, the GDP rates for the livestock sector of 3.2% and 5% of the forestry sector are expected to stay stable, whereas the groundnut production is expected to be only 3% of the GDP.




* Figures for selected years are IMF staff estimates / projections

**Figure 12: Annual Percent Change of Consumer Prices (1987 - 2006)**




* Figures for selected years are IMF staff estimates / projections

**Figure 13: Annual Percentage Change of Real GDP (1987 - 2006)**

In case of the fisheries sector, further development is expected and the forecast is thus an average 4.4 GDP percentage for the period of 2005-2010.

Speaking of the industry and infrastructure sector, an average GDP rate of 4.8% is expected for the period 2005-2005%. A stable annual percentage of 5% is foreseen for all of the branches of this sector during the years 2007-2010. This shall be realised for instance by employment in the manufacturing sector, which is expected to grow 4.7% in 2005-2010. This target is in conformity with the objective of improving the income status of Gambian people. Concerning the manufacturing industry, furthermore net increase in the number of industrial units, greater diversification of industry, and the capturing of an established and growing export market shall be realised by the year 2020.

Referring to other industrial branches, in one of the sources establishing economic objectives, “Vision 2020”, which was published electronically in 1996 by the Gambia’s government, an objective of an unlikely high increase in overall energy generating capacity is formulated. However, it is mentioned that this objective should not be overemphasised, as the primary target is to overcome the existing bottlenecks. Sufficient energy supply, the upgrade and expansion of the seaport, airport, road and waterway network and the free flow of information by the means of telecommunication and multimedia are considered as pre-requisite for the defined future economic objectives

In respect of the service sector, especially concerning the tourism industry the number of tourism visitor arrivals is expected to grow 20% annually for 10 years from 2003 on. In general, greater collaboration between the public and private sectors is envisaged in the provision of modern tourism infrastructure, but also in the other service sectors.

First projections of the percentage change of consumer prices and the real GDP are exposed in comparison with the past and current development of the Gambia’s economy in Figure 12 and Figure 13. A detailed break-down for the future development of the sectors agriculture, industry and services and their branches respectively is displayed in Annex 5 of this report.

# 5 ASSESSMENT OF ENERGY CONSUMPTION

The Gambia relies almost entirely on biomass (wood fuels) and imported petroleum products to meet its energy requirements. However, in the face of rapid depletion of forest reserves due to bush fires, farming, etc. the energy options with biomass are very limited. In addition, due to high cost of imported petroleum products, the National Electricity and Water Company (NAWEC) is finding it extremely difficult to service the growing import oil bills particularly for electricity generation.

The country depends mostly on foreign aid to cover its needs of petroleum products, and as result, development efforts have been curtailed, especially in rural areas. Because of the possibility that economically exploitable deposits of petroleum exist in the Gambia, exploration is being actively pursued by the Government.

The following sections provide an assessment of the utilisation of primary energy sources such as fuelwood and the several oil products (heavy fuel oil, kerosene, diesel and liquefied petroleum gas). The present situation and historical development will be explained for each energy source. Furthermore the situation within the several consumer sectors (residential, industrial, commercial, institutional and agricultural sector) will be discussed in detail, and finally, the national energy balance is being divided.

The consumption characteristics of the secondary energy source – electricity - will be evaluated separately. Chapter 6 “The electricity consumption” addresses the conditions at the Gambia’s electricity sector.

## 5.1 CONSUMPTION OF FUELWOOD

Fuelwood represents the major source of domestic energy in the Gambia. The fuelwood resource-base is the forest, which covers the country constituting about 43% of the total land area[4]. It comprises the closed woodland, open woodland and savannah woodland. Fuelwood energy sources are firewood and its derived charcoal.

Cooking is the main purpose for which fuelwood is applied in the country. The evaluation of census results show that nearly 92% of the population use firewood for cooking and some 4% use charcoal. A more detailed insight into households energy requirements provides the section “Energy Consumption in the Residential Sector”.

However, fuelwood consumption in the country has been estimated at various levels by different authors with a wide range. There were several studies (Openshaw, 1973, CILSS 1977, Carlowitz 1980, Orgatec 1982, Bulow 1983, Foley 1994, Steiner 1994 and the latest Kinteh 2005) that were conducted to estimate the fuelwood demand of the country.

[4] Source: DMCI, Development Management Consultants International.
“Household Energy Strategy for the Gambia”, 2005

Charcoal Iron

Firewood
The dominating primary energy source

**Figure 14: Energy Sources / Energy Devices for Heat Generation / Cooking in the Residential Sector**

The results were quite different. The consumption rate per capita varies from 1.44 $m^3$ per capita and per annum (Openshaw, 1973) to 0.34 $m^3$ (Foley, 1994). It is recognisable, that the consumption rate for fuelwood decreased considerably during the time when the various studies were prepared. Only the Kinteh-Study (2005) does not follow that trend. It provides a consumption rate of 1.13 $m^3$ per capita and annum.

To apply a capable data base within this study, the Consultant refers to discussion results, as well as official data published by the Energy Division in recent years. The total fuelwood consumption is estimated at 374,890 TOE/a in the year 2004, which is equal to a specific

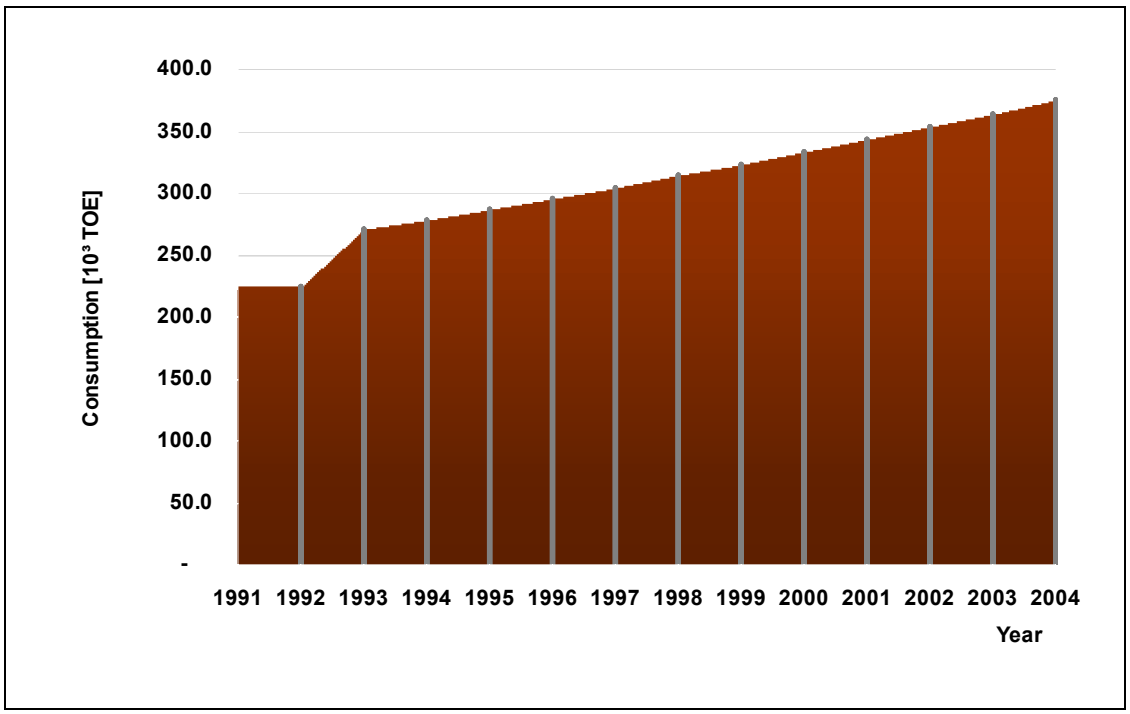



**Figure 15: Development of Energy Consumption – Fuelwood (1991-2004)**

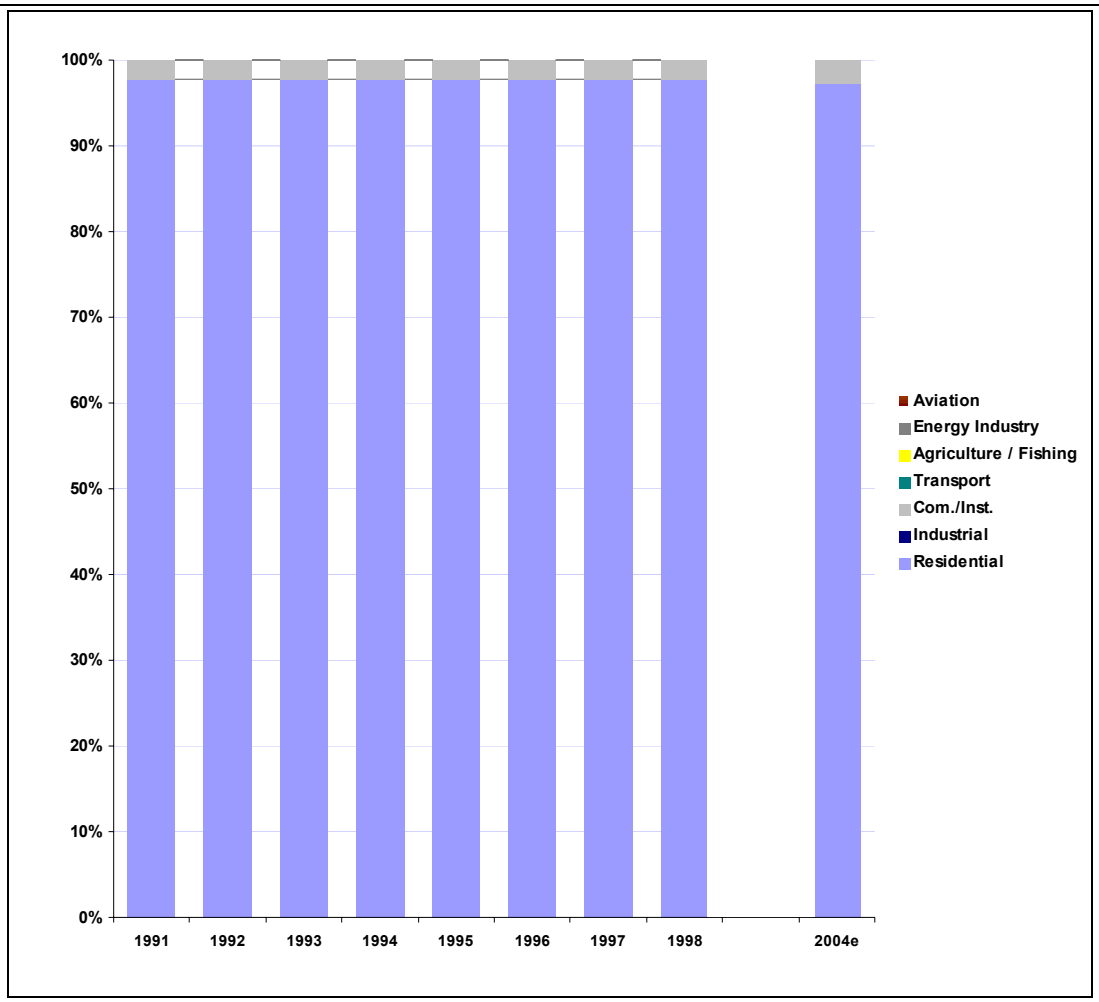



**Figure 16: Development of Proportions in the use of Fuelwood**

consumption of 0.27 TOE per capita and annum or 0.61 m³. Although the production and marketing of charcoal have been banned in the country since 1980, charcoal remains the leading fuel for ironing in a large proportion of households, as well as for roasting corn and groundnut and food vending operation in the streets. The Forest Act and Regulations of 1998, section 108 (1) prohibited the production of charcoal in any parts of the country but provision are made for the importation and sale of charcoal in the Gambia. The proportion of charcoal in fuelwood consumption is estimated at 5%. The latest most comprehensive study in that matter (Kinteh, 2005) provide an annual consumption of 11,038 TOE/a only within the residential sector.

Figure 15 illustrates the present annual fuelwood consumption and provides a trend within the period 1991-2004. The average annual growth over the period 1991-2000 amounts to 4.4%. During the last four years, it is estimated at 3.0%.

Three-Stone cooking site
Most common type of cooking in households

Capital's Commercial Centre

**Figure 17: Impressions of the Residential and Commercial Sector in The Gambia**

Figure 16 illustrates the present sector break down and its historical development. The shares of the dominating residential sector and the commercial/institutional sector are nearly constant during the entire period under consideration. While the composition was 97.8% to 2.2% in the year 1991, for today a composition of 97.3% to 2.7 % is estimated.

## 5.2 CONSUMPTION OF PETROLEUM PRODUCTS

The petroleum requirements of the country consist of gasoline (premium and regular), diesel oil (gas oil), liquefied petroleum gas (LPG), heavy fuel oil (HFO), kerosene and aviation (jet) fuel. Currently petroleum products are supplied by two major international companies (Shell and Elf) and recently Castle and the start up of Elton Oil. The existing facilities for handling petroleum supplies and distribution are an oil pipeline for discharging tankers at the Banjul Port, a storage depot and over 43 retailing stations countrywide. The petroleum storage depot covers an area of about 10,500 m² situated in the heart of Banjul with a total capacity of 17,000m³.

The marketing of petroleum products is basically carried out by the petroleum companies through the retail stations owned and operated by private dealerships, which are financially independent of the marketing companies. Distribution of petroleum products is done through oil tankers for quantity imports from overseas; and in-country distribution to retailers by lorries (10 tons and above).

The consumption of liquid products grew from 74,200 TOE/a in 1991 to 112,390 TOE/a in 2004. There was a steady growth in the consumption of petroleum products. Over the period 1991-2000 the annual growth rate amounted to 2.2%. Within the last four years 2000-2004 a higher increase of some 5.7% was observed. Today the main petroleum

products are Diesel, HFO and Gasoline. Figure 18 shows the proportion in the year 2004. An overview of the development of petroleum products consumption is given in Figure 19. It shows, that in particular HFO's proportion in the petroleum product mix grew significantly in the past decades.

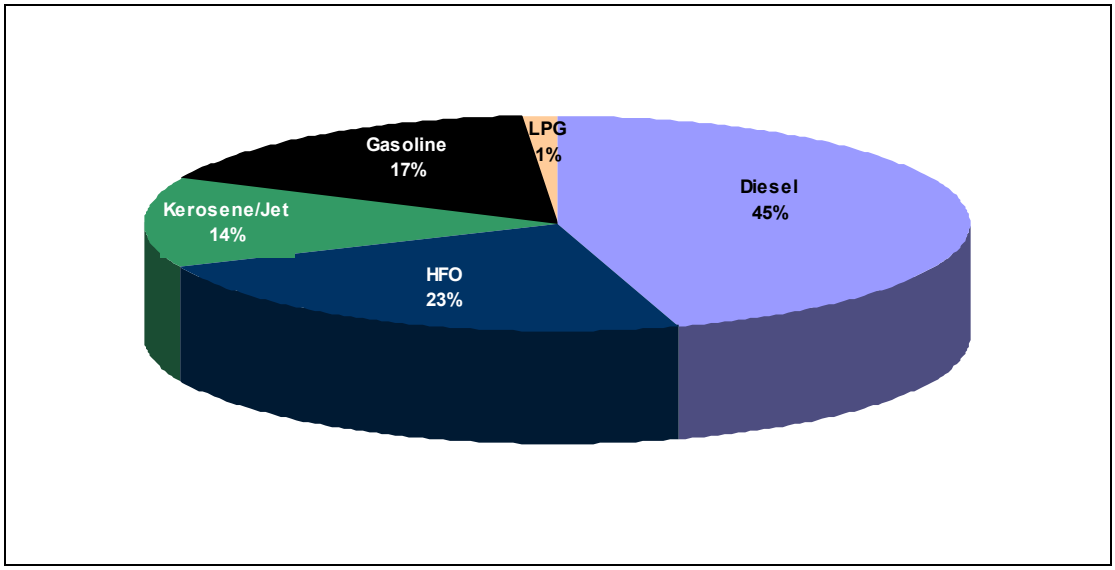



**Figure 18: Composition of Petroleum Products Consumption (2004)**

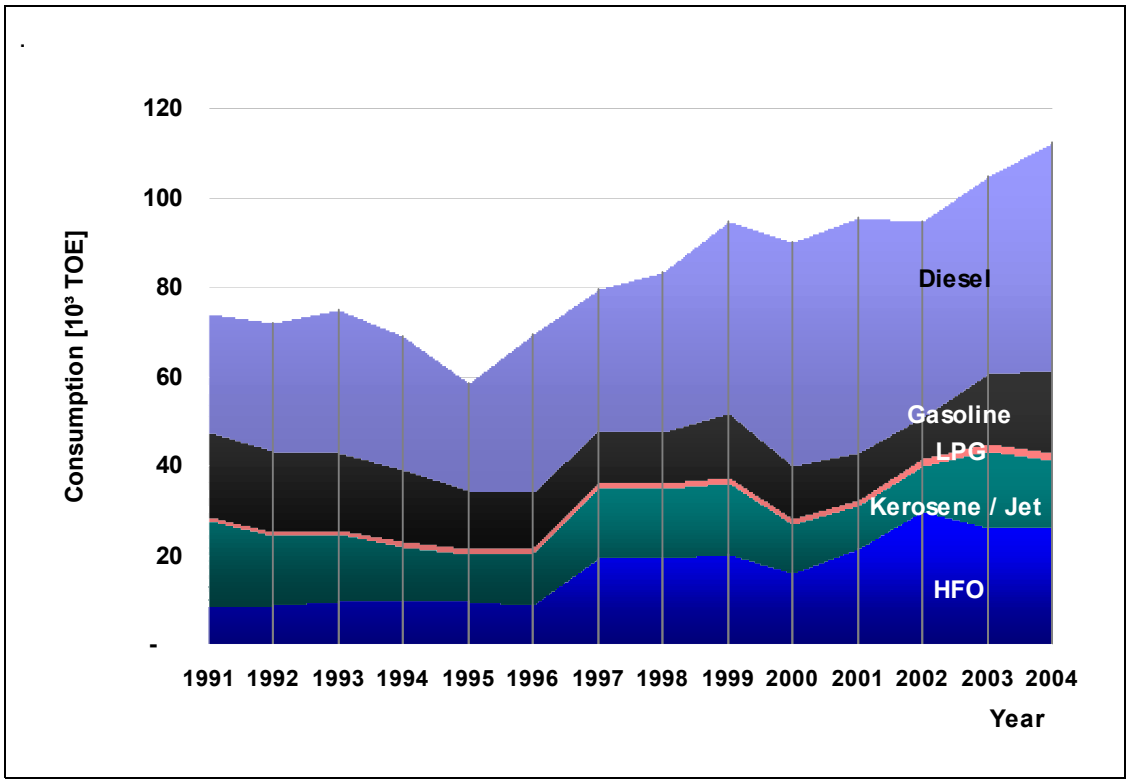



**Figure 19: Development of Energy Consumption – Petroleum Products (1991-2004)**

In the following the requirements for each individual petroleum product will be analysed. Beside total figures, consumption characteristics divided by customer sectors will be discussed.

### 5.2.1 Diesel

In 2004 about 50,790 TOE diesel fuel were consumed in the Gambia. The average annual rate of increase was 7.3% between 1991 and 2000. Diesel fuel consumption stagnated after that period. The growth rate over the past four years amounted at an average of only 0.3%.

With approximately 81% the largest share is taken up by the transport sector (including public or private transport services, private vehicles, government and diplomatic vehicles, as well as building and public works).

The country, like many other developing countries, is heavily dependent on imports of diesel fuel to generate electricity. The national utility consumed 1,610 TOE in the year 2004 (3% of total consumption). The NAWEC operates several thermal power stations that run on either diesel and/or heavy fuel oil. In recent years, NAWEC decreased significantly the proportion of diesel to generate electricity. Today heavy fuel oil is the dominating energy source in this matter by some 94%. Three years ago in 2001 the proportion even was 56%.

Sectors like industry, commercial and small parts of the residential sector apply in particular diesel fuel for stand-up or permanent self electricity generation. NAWEC experts estimate the installed capacity in those sectors by the factor 1.5 compared to it's own generation capacity. The total diesel consumption of the industrial, commercial and institutional sectors amounts to approximately 7,110 TOE/a (14% of total).

Groundnut processing plant in the Greater Banjul Area

Traffic in The Gambia's Capital

**Figure 20: Impressions of the Industrial and Transport Sector in The Gambia**

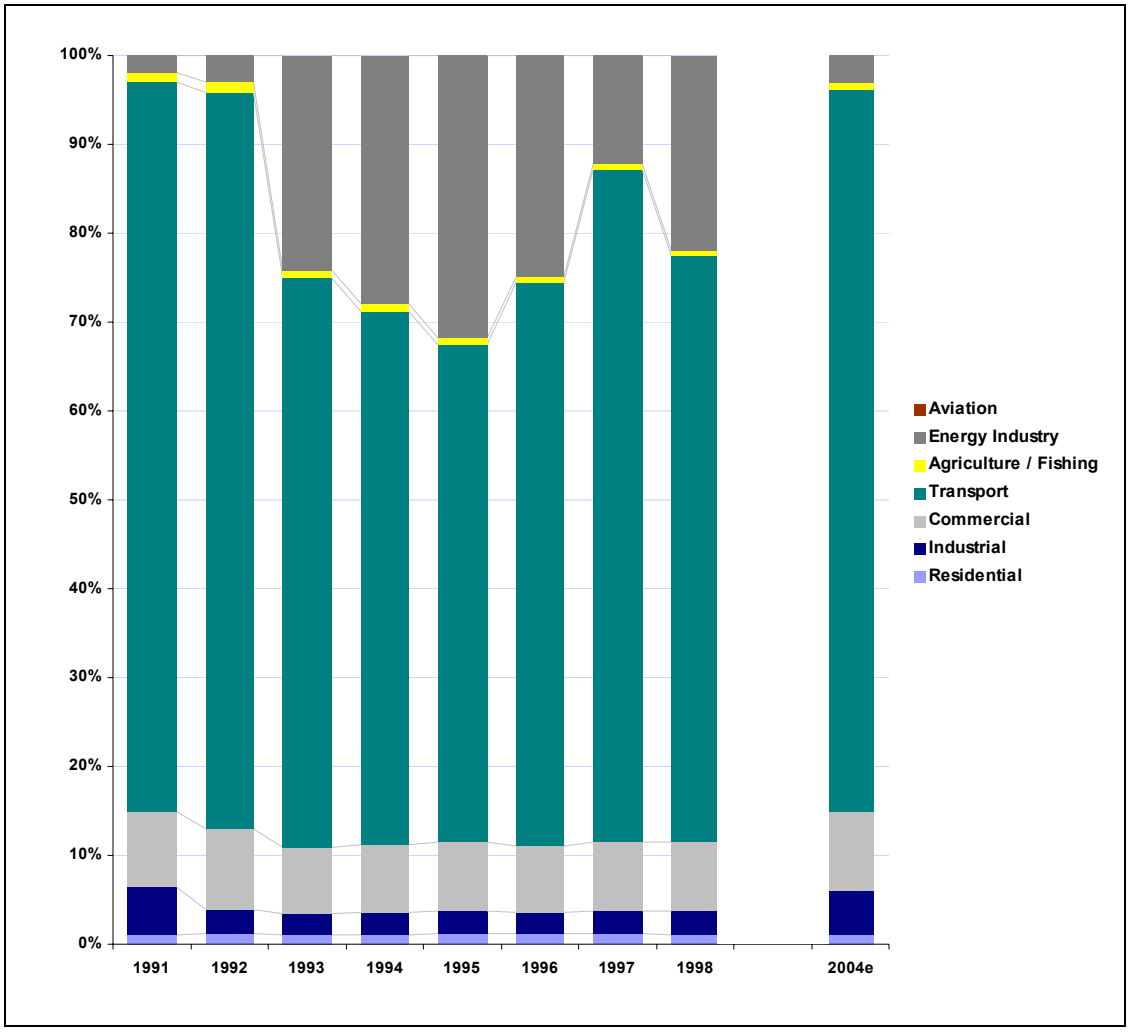



**Figure 21: Development of Proportions in the use of Diesel**

The above figure illustrates the sector breakdown in terms of diesel fuel use. Remarkable is the interplay between diesel consumption within the energy industry and transport sector. Based on available data and discussions with energy division's expert the break down for the present situation was estimated as follows:

- Residential Sector: 1 %
- Agriculture and Fishing Sector: 1 %
- Industry incl. Energy Industry: 8 %
- Commercial and Institutional Sector: 9 %
- Transport Sector: 81 %

### 5.2.2 Heavy Fuel Oil

In 2004 about 26,070 TOE heavy fuel oil were consumed in the Gambia. The average annual growth rate was 7.6% between 1991 and 2000. HFO consumption further rises very drastically. HFO is that energy source with the highest rate of increase in the past. Over the past four years average annual change amounted at 13.2%!.

With a share of about 98% the energy industry plays the dominating role in the use of heavy fuel oil. As already described within the previous section, NAWEC has substituted more and more the fuel input in its power stations by HFO instead of diesel. In addition, new power generating units started operation at the end of the nineties and the beginning of that millennium (commissioning year 1997: TPP Kotu unit 3 and unit 11; commissioning year 2001: TPP Kotu unit 4R, unit 7 and unit 8). The impact of units' commissioning is clearly recognisable in Figure 22, which shows the development of HFO consumption over the period 1991 up to 2004.

At present the energy industry alone requires 25,500 TOE/a of HFO. The remaining amount is exclusively used by the industrial/manufacturing sector, with nearly 510 TOE/a. The proportion of HFO consumption by sector is shown in Figure 23. The figure illustrates that the consumption caused by the energy industry increased more and more over the past 15 years. The ratio of energy industry consumption to total consumption increased from 93% in 1991 to 98% in 2004.

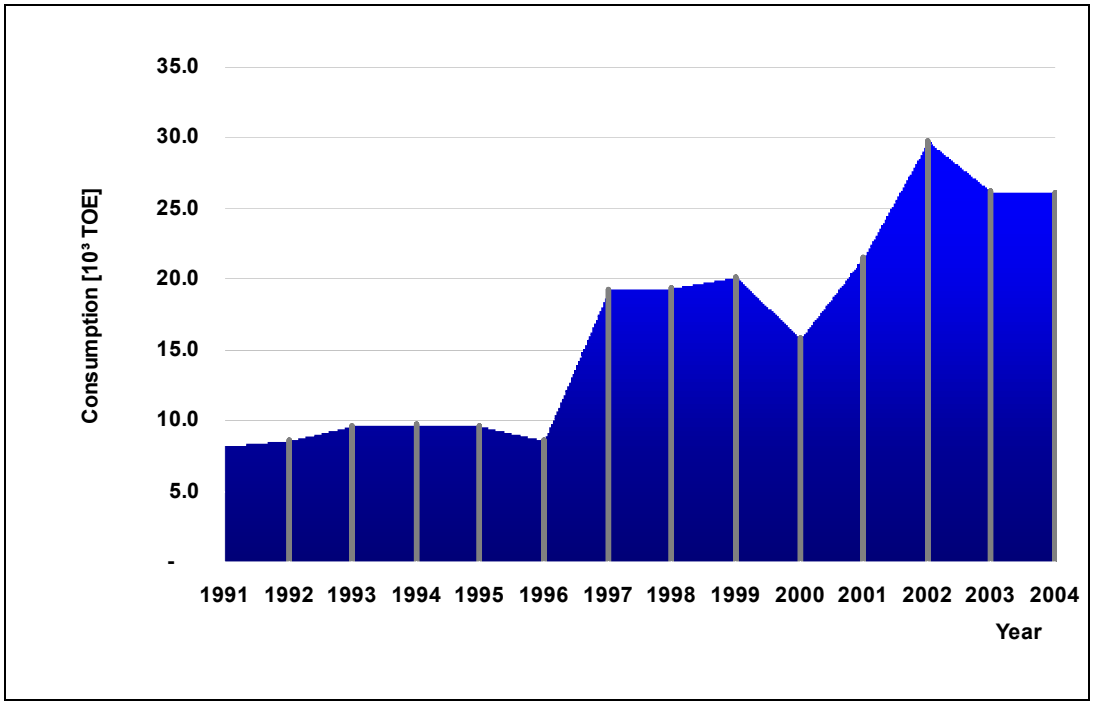



**Figure 22: Development of Energy Consumption – Heavy Fuel Oil (1991-2004)**

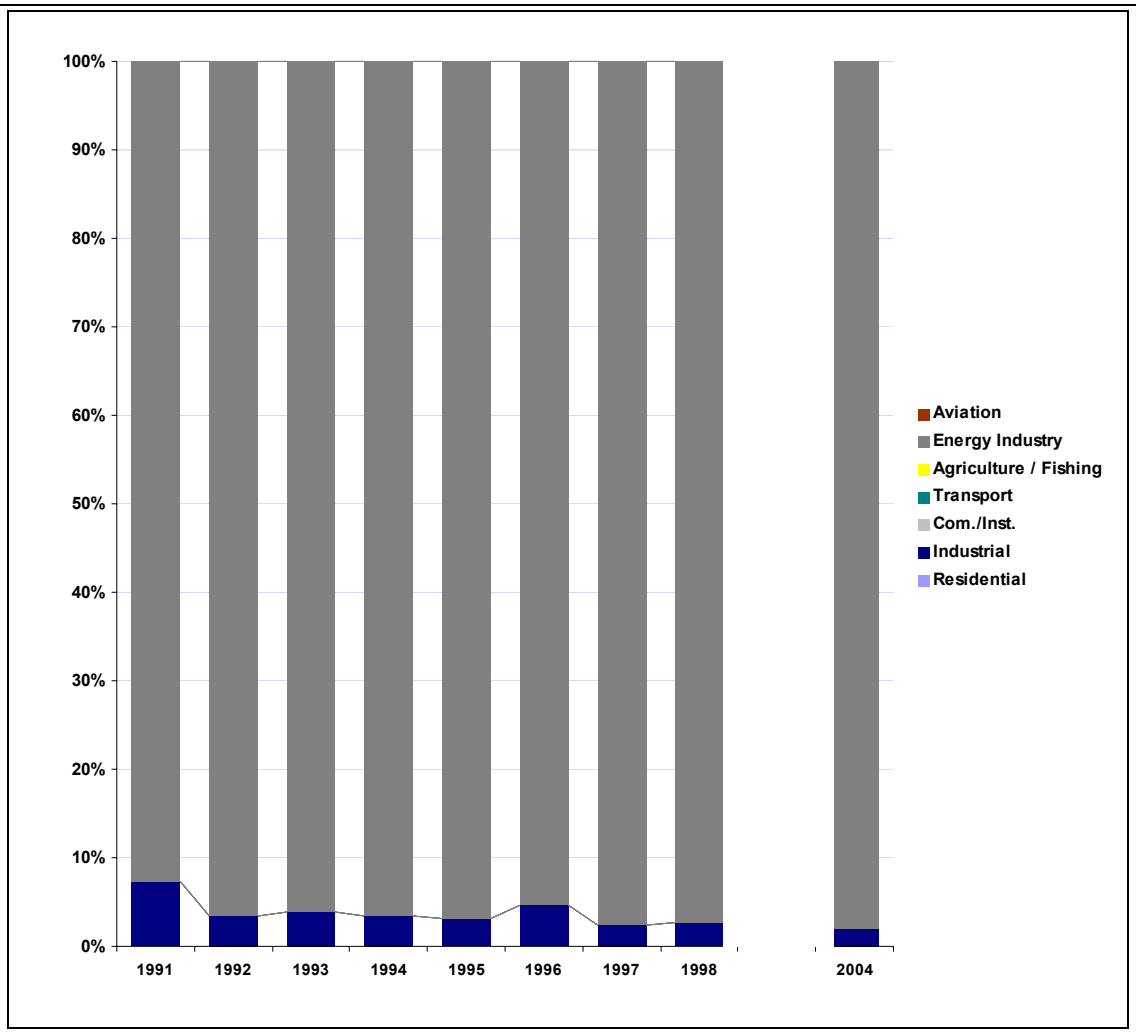



**Figure 23: Development of Proportions in the use of HFO**

### 5.2.3 Gasoline

Behind Diesel and HFO, Gasoline ranks on third place within the frame of petroleum products consumption with a share of 17%. In 2004 approximately 18,600 TOE of gasoline were consumed in the Gambia. Between 1991 and 2000 a reduction of gasoline consumption is observed. During this period, the average annual change was -5.2. In 1991, nearly 19,000 TOE were used almost exclusively by the transport sector. Over the years the consumption of gasoline dropped to the half of the amount by 1991. Only 11,690 TOE have been the annual consumption in 2000, and the minimum with some 9,420 TOE was reached in 2002. In recent years, gasoline consumption jumped by two-digit annual growth rates. During the years 2003-2004, the rate of increase was 18.8%.

Figure 24 below gives an insight into the sectoral consumption of gasoline. Naturally, the transport sector is dominating. In 2004, the proportion amounted to 95%. With about 4%

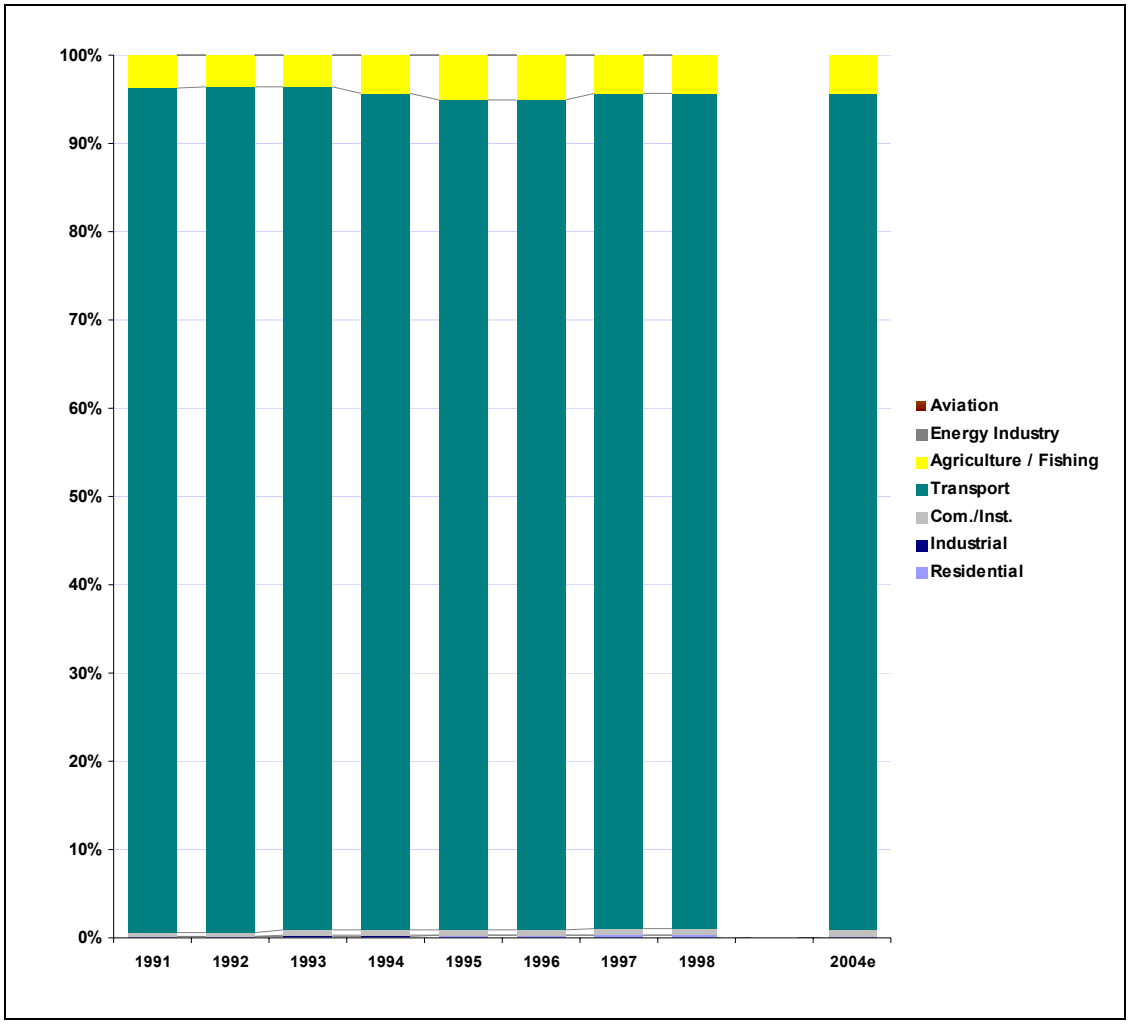



**Figure 24: Development of Proportions in the Use of Gasoline (1991-2004)**

the transport sector is followed by agriculture and fishing. The remaining small share is caused by the commercial, institutional and residential sector.

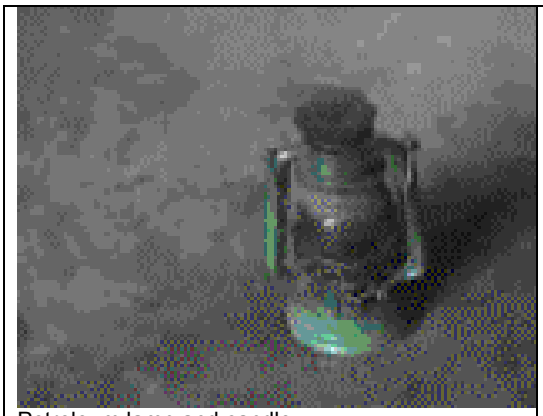
### 5.2.4 Kerosene and Jet

In 2004 about 15,350 TOE of Kerosene / Jet were consumed in the Gambia. The fuel can be divided into two kinds of application:

- Kerosene, which is 100% applied in the residential sector; and
- Jet fuel, which is 100% applied for aviation.

Kerosene is mainly used for lighting. Attempts to promote improved kerosene oven for cooking resulted in only marginal market penetration. Kerosene is one of the most important energy sources for lighting in *rural* households, as these do not have access to electricity. The amount

of kerosene consumption in 2004 is estimated at 5,770 TOE, about 38% of total kerosene / jet consumption.



Petroleum lamp and candle
Candles are the most common source for lighting in rural areas

Kerosene lamp
Kerosene lamps are the second most common source for lighting in rural areas

**Figure 25: Energy Sources / Energy Devices for Lighting in the Residential Sector**

In the past, several fluctuations in the use of Kerosene/Jet were observed, mainly caused by the consumption characteristics of the transport sector (aviation). Over the period 1991 to 2000, the average annual change was -6%. In that period, the minimum was reached in the year 1995 with some 10,520 TOE/a. The maximum was observed at the beginning of this decade in 1991. Approximately 19,350 TOE/a were used during this year. Over the last four years, the average annual change amounted to 8.4%. Figure 26 below shows the development of Kerosene / Jet consumption over the period 1991 to 2004.

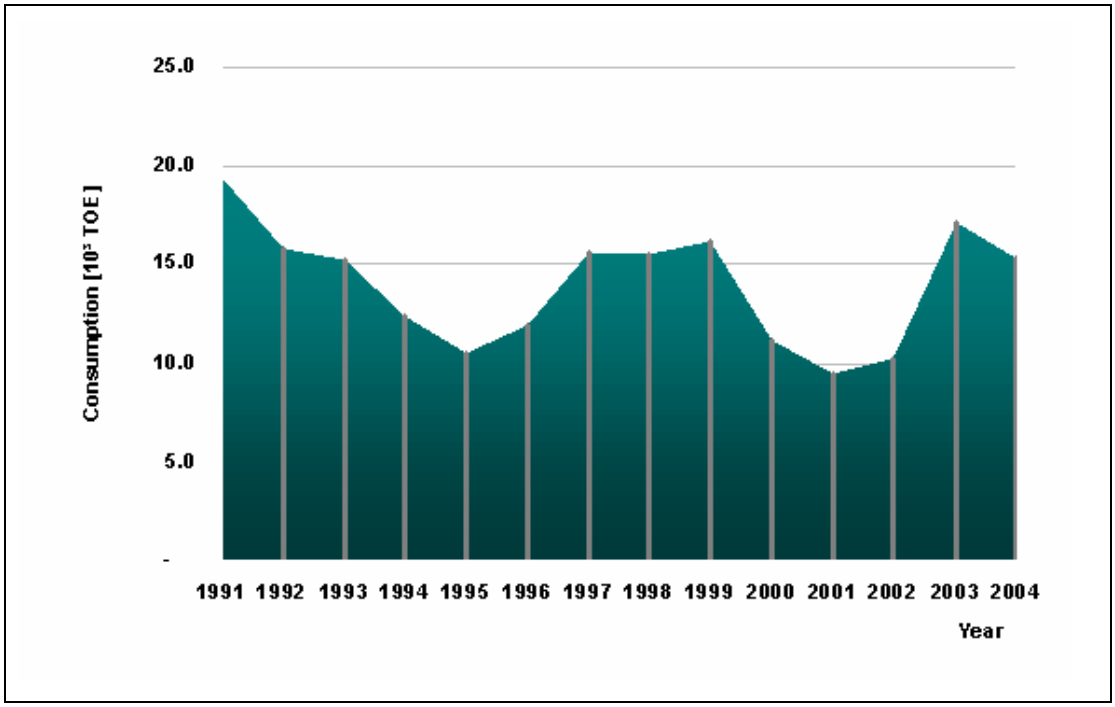



**Figure 26: Development of Energy Consumption – Kerosene / Jet**

### 5.2.5 Liquefied Petroleum Gas

The total consumption of liquefied petroleum gas (LPG) is estimated at 1,590 TOE/a in the year 2004. LPG is used for cooking and heat generating purposes. 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. The 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. Nevertheless, the average annual growth rate of LPG consumption was 7.3% between 1991 and 2000. Over the past four years the annual consumption was nearly stable. A growth rate of some 0.3% was observed during the period 2000-2004.

Figure 27 below presents the quantities of LPG used between 1991 and 2004. The figures are based on analyses of import figures and estimations by LI and the Gambia's Energy Division. As shown in the graph, annual consumption has nearly doubled within the last fifteen years. A break down by sector is presented in Figure 28. No significant change of the proportions is registered. The commercial/institutional sector causes 40%, the remaining 60% contributes the residential sector.

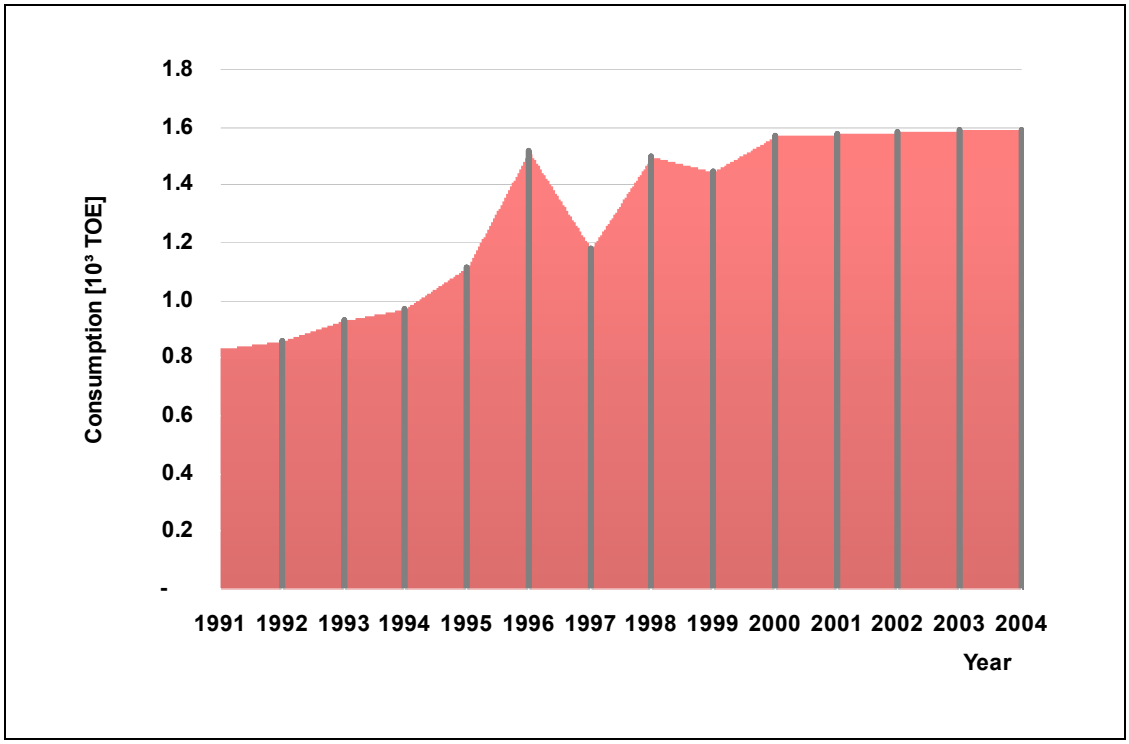



**Figure 27: Development of Energy Consumption – LPG**

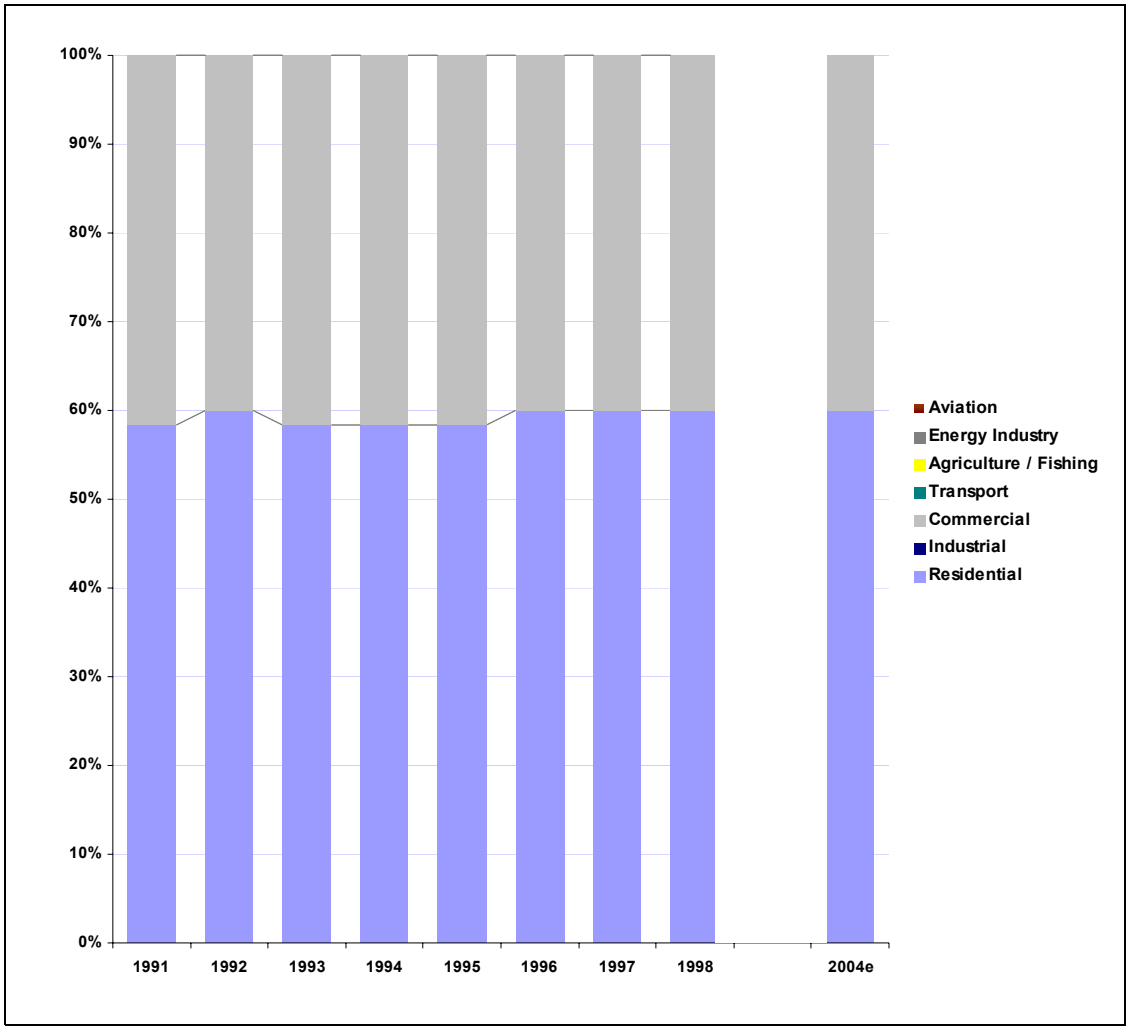



**Figure 28: Development of Proportions in the Use of LPG**

## 5.3 URBAN AND RURAL CHARACTERISTICS OF ENERGY REQUIREMENTS

Before discussing the regional characteristics (in particular urban and rural area diversification) this section explains the consumption of primary energy sources by sector. Within Annex 5, a detailed overview concerning this matter is provided.

The ***residential sector*** is the sector with the highest primary energy consumption compared to all other sectors. This is due to the high consumption of fuelwood with approximately 378.3 thousand TOE/a. The use of fuelwood amounts to more than 98% of the sector's total primary energy requirements. Diesel contributes only 0.1%, Kerosene 0.9% and LPG 0.3%. Due to its dominating role in the Gambian energy system, the Consultant has assessed comprehensively the characteristics of energy application for the main energy-intensive household activities. The following results are mainly based on the latest evaluations of the Central Statistics Department of the Gambia. Furthermore, it should be borne in mind, that the following figures do not only consider primary energy sources like in all pervious sections of this chapter. Because of the

fact, that energy consumption surveys consider the demand side (the end of energy supply chain) also secondary energy sources, such as electricity or candles, are included in the following compilations.

The most energy-intensive activity in households is cooking. About 92% of households in urban areas use fuelwood for that purpose (84.5% firewood, 7.5% charcoal). In rural areas the proportion is even larger, with some 99% (98.6% firewood, 0.5% charcoal). While gas use can be noted at least as recognisable in urban places, other energy sources in rural areas show per-mill-ranges. Table 8 gives an overview for urban and rural areas of the Gambia. In addition, Annex 6 provides detailed figures for each the legal and the administrative area, described in Section 3.1.

Large differences in urban and rural areas are observed in the use of energy sources for lighting. First of all, the major source is the same, 47.1% of urban households, and 51% of rural households use candles. In urban regions, candles are followed by electricity. Electricity is supplied by NAWEC (more than 40% of households), conventionally self-generated

**Table 8: Use of Energy Sources for Cooking in Urban and Rural Areas (Finalised Results of Census 2003)**

| Total | Population | Main Cooking Fuel [%] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | [capita] | Firewood | Kerosene | Briquette | Charcoal | Gas | Electricity | Solar | Saw Dust |
| Urban | 686,090 | **84.54%** | 0.29% | 0.10% | 7.50% | 6.64% | 0.07% | 0.02% | 0.85% |
| Rural | 674,568 | **98.62%** | 0.22% | 0.16% | 0.48% | 0.47% | 0.00% | 0.03% | 0.00% |

Cooking site and utensils

Typical Three-Stone Cooking

**Figure 29: Impression of Cooking in Households**

**Table 9: Use of Energy Sources for Lighting in Urban and Rural Areas (Finalised Results of Census 2003)**

| Total | Population | Main Source of lighting [%] | | | | | |
|---|---|---|---|---|---|---|---|
| | [capita] | Electricity (NAWEC) | Electricity (Generator) | Kerosene Lamps | Candle | Solar | Firewood |
| Urban | 686,090 | **40.2%** | 1.5% | 10.3% | **47.1%** | 1.0% | 0.0% |
| Rural | 674,568 | 1.0% | 0.8% | **45.1%** | **51.0%** | 1.6% | 0.6% |

(1.5%) or generated by solar PV-systems (1%). In rural households, kerosene lamps rank on second place. More than 45% of the households use simple kerosene lamps for lighting purposes. Other sources such as electricity and firewood take a marginal share. Table 9 shows the country-wide proportions. In detail, Annex 6 gives an overview of all local and administrative areas in the Gambia.

The use of energy sources in the ***industrial sector*** (including energy industry) is nearly limited to the consumption of diesel and heavy fuel oil. Almost 14% of total consumption in the sector is allocated to diesel, and the remaining 86% to HFO. Industrial customers are to 100% located in urban agglomerations, and an estimated proportion of 90% alone in the Greater Banjul Area.

A similar regional classification is applied for the ***commercial / institutional* sector**. Major institutional and commercial facilities are situated in the capital Banjul. Smaller institutions of local authorities belongs to urban areas. Small-scale commercial places, as well as primary and secondary schools can be found in each part of the country. Fuel-

Electricity supply by NAWEC
Greater Banjul Area

General National Hospital in Banjul

**Figure 30: Impression of Industrial and Institutional Sector in the Gambia**

wood dominates the energy use in this sector, with a share of 65.5% of the total primary energy consumption. Fuelwood is followed by diesel (29.6%), liquefied petroleum gas (4.1%), and a neglectable proportion of gasoline (0.8%).

The ***agricultural sector*** (including fishing) shows a reverse regional composition. In recent years, agricultural output declined in urban areas (in particular in the Greater Banjul Area due to limitation and reduction of farmland). Major primary energy sources used in the agricultural sector are fuels like diesel (30.4%) and gasoline (69.6%). The level of mechanisation in the agriculture is very low. Many of agricultural activities are still carried out by manpower. Therefore, the agriculture sector is the sector with the lowest energy input compared with all other consumer groups. Furthermore, the energy consumption per region is quite different. Table 10 shows the number of machines / devices per rural area in the different Local Government Areas. These figures are the results of the 2003/2004 national agricultural sample survey published by the Agricultural Statistics and Resources Economics Unit (ASRE) in 2004. They provide an indication of mechanisation and related energy use within the regions analysed.

**Table 10: Tools and Implements used by crop fields planting / harvesting by LGA (2003)**

| Local Government Area / District | Tractor | Electric Motors | Power Tilers | Threshing Equpiments | Other Machines | Groundnut Lifter | Cart | Other |
|---|---|---|---|---|---|---|---|---|
| **NATION-WIDE RURAL AREAS** | **2,369** | **466** | **100** | **316** | **691** | **77,182** | **191,583** | **200,718** |
| LGA OF BRIKAMA | 959 | 150 | 100 | 316 | - | 5,934 | 23,740 | 45,997 |
| LGA OF MANSAKONKO | 457 | - | - | - | 660 | 2,909 | 13,577 | 26,184 |
| LGA OF KEREWAN | 162 | 316 | - | - | - | 26,955 | 47,172 | 32,010 |
| LGA OF KUNTAUR | 129 | - | - | - | - | 13,772 | 31,478 | 20,985 |
| LGA OF GEORGETOWN | 212 | - | - | - | 31 | 18,201 | 36,403 | 33,192 |
| LGA OF BASSE | 450 | - | - | - | - | 9,411 | 39,213 | 42,350 |

Source: 2003/2004 National Agricultural Sample Survey, Agricultural Statistics and Ressources Economics Unit (ASRE), et.al.

Rice Cultivation in the Greater Banjul Area

Groundnut harvest in rural areas

**Figure 31: Impressions of the Agriculture Sector in The Gambia**

The ***transport sector*** covers the energy sources diesel, gasoline and jet. The latter type is applied exclusively in the Gambia's aviation with the country's gateway the Banjul International Airport. Jet consumes 16.9% of the total energy in the transport sector. Other transport sub-sectors, such as road transport; maritime and river transport, are also concentrated in the Greater Banjul area. The major sources are diesel (58.2% of total sector requirements) and gasoline (24.9% of total). It is estimated that 85% of the transport activities take place in the urban agglomerate around the capital, the remaining 15% in country's provinces.

## 5.4 SEASONAL CHARACTERISTICS OF ENERGY REQUIREMENTS

This section describes the seasonal and monthly characteristics of primary energy consumption. First the main climatic conditions, which can influence seasonal energy use will be explained.

The Gambia lies in the Sahelian agro-climate zone and has perhaps the most agreeable climate in West Africa. There is subtropical climate with distinct dry and rainy seasons. The dry season is from November to May with temperatures as low as 16°C in Banjul and surrounding areas, and the Harmattan wind keeping the humidity low. Daytime temperatures may rise as high as 41°C between March and June. The rainy season is from June to October with hot, humid weather; during this period, average temperatures range from 23°C up to 32°C. In general, there is considerable cooling off in the evening. The mildest temperatures are along the coastline.

Average annual rainfall on the coast amounts to 1.45 mm, while less rain is falling in inland that with about 92 mm. Even in the rainy season, sunny periods occur on most days. There has been a steady decline in rainfall from 1,875 onwards, which still continues and which is causing increased salinity in the lowlands and increased aridity in the uplands.

**Table 11: Average Climatic Conditions in The Gambia (Banjul)**

| Month | Temperature Average Min | Max | Discomfort from heat and humidity | Relative humidity am | pm | Average Precipitation (mm) | Wet Days (+2.25 mm) |
|---|---|---|---|---|---|---|---|
| Jan | 15 | 31 | Medium | 67 | 27 | 3 | 0.1 |
| Feb | 16 | 32 | Medium | 66 | 26 | 3 | 0.3 |
| Mar | 17 | 34 | Medium | 76 | 29 | 0 | 0 |
| Apr | 18 | 33 | High | 82 | 41 | 0 | 0 |
| May | 19 | 32 | High | 88 | 49 | 10 | 0.9 |
| Jun | 23 | 32 | High | 91 | 61 | 58 | 5 |
| Jul | 23 | 30 | High | 94 | 72 | 282 | 16 |
| Aug | 23 | 29 | High | 95 | 78 | 500 | 19 |
| Sep | 23 | 31 | High | 95 | 73 | 310 | 19 |
| Oct | 22 | 32 | High | 95 | 65 | 109 | 8 |
| Nov | 18 | 32 | Medium | 90 | 47 | 18 | 0.8 |
| Dec | 16 | 31 | Medium | 77 | 36 | 3 | 0.2 |

SOURCE: bbc.co.uk WORLD WEATHER COUNTRY SIDE GAMBIA

Table 11 above summarises selected parameters of the climatic conditions, such as average temperatures and rainfall over a period of one year. Weather conditions can influence the output of the agricultural sector and the related energy consumption. Referring to this also the energy consumption of related sectors such as transport, but in particular agricultural product processing industry can be influenced by fluctuations in temperature or rainfall.

In many countries the residential sector is that sector with the highest dependence of seasonal energy consumption on climatic conditions. This is due to space heating in cold seasons and/or air conditioning in hot seasons. Space heating is not relevant in the Gambia, and also the use of air conditioning devices is marginal. Furthermore the fluctuation of monthly average temperatures are very low, as illustrated in the following graph. The comparison of average maximum values show a difference of only 5 Kelvin (34°C in March; 29°C in August). Even if the use of air conditioning devices would increase, no drastically seasonal fluctuations would occur.

Another important determinant of daily, monthly or seasonal consumption figures is the number of hours per day between sunrise and sunset. In European countries for example the difference between maximum and minimum is very high (e.g. in Germany it varies

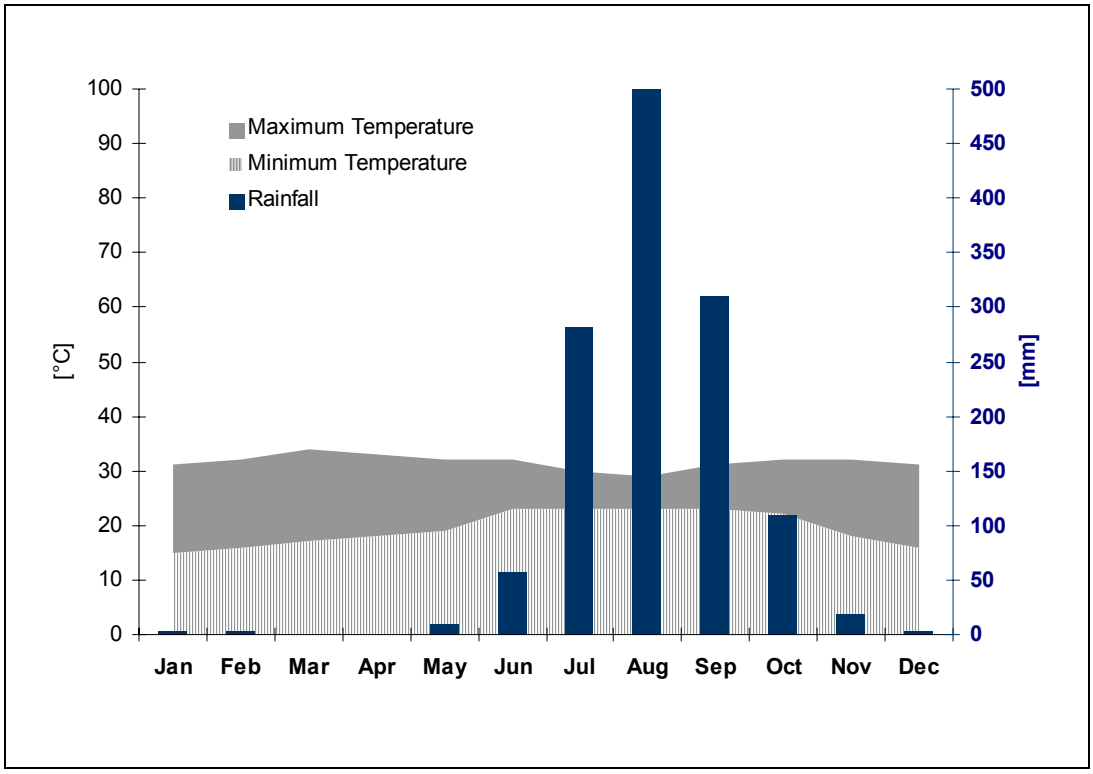



**Figure 32: Temperature and Rainfall Profile in The Gambia (Banjul)**

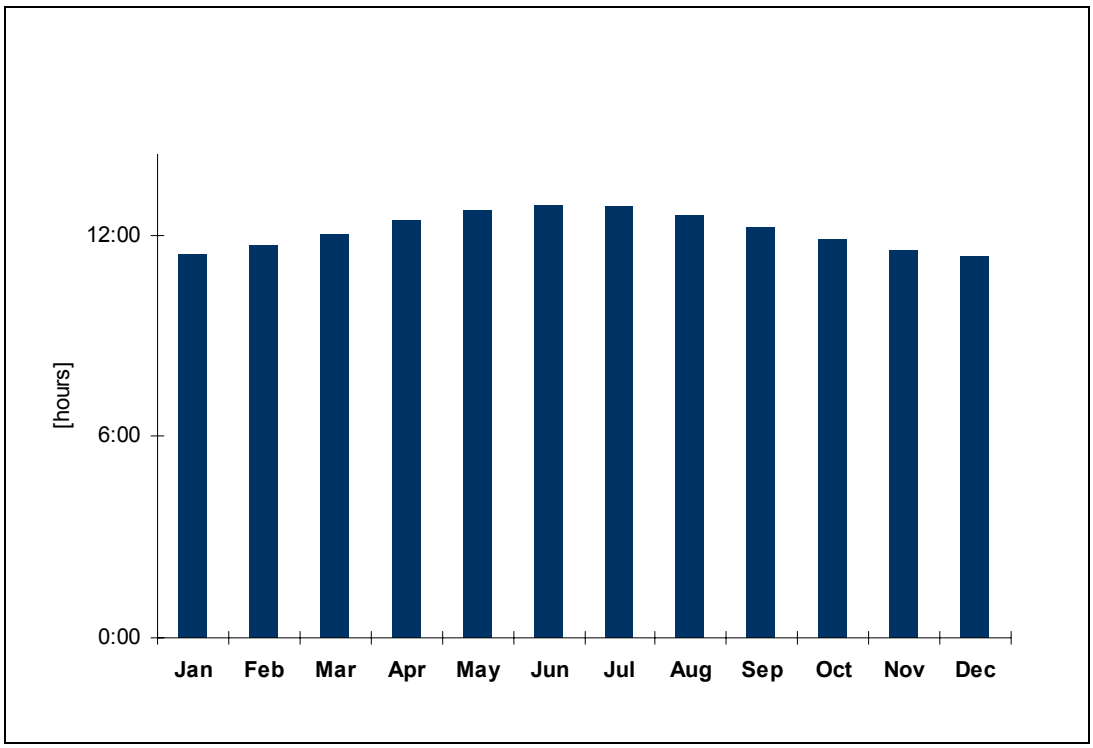



**Figure 33: Average Number of Hours between Sunrise and Sunset**

between less than 8 hours a day during winter and more than 16 hours a day during summer). Energy use for lighting increases drastically during periods with short times of daylight. In the Gambia the number of hours between sunrise and sunset fluctuates not significantly. Figure 33 shows the profile over the year. The maximum is observed in June/July with about 12:50 hours. The minimum occurs in December/January and amounts to 11:20 hours. Deviations from the overall average (12:05 hours) are low, with only about 45 minutes. Concerning this matter, no important fluctuations are expected in terms of monthly / seasonal energy consumption.

Certainly, agriculture's harvest time and tourism branches' peak period have an impact on the monthly consumption of energy. But due to the low proportion of these (sub-) sections the impact on the overall requirements is quite low.

The following graphs show the monthly profiles for the main primary energy sources. The figures are based on sales and supply statistics and are presented non-dimensionally (100% values are equal to the maximum monthly figure for each energy source). The graphs show that there is no actual returning seasonal pattern. Within the "diesel graph" (Figure 35) an additional comparison of 2004 and 2003 values is presented. Again, no typical seasonal pattern can be pointed out.

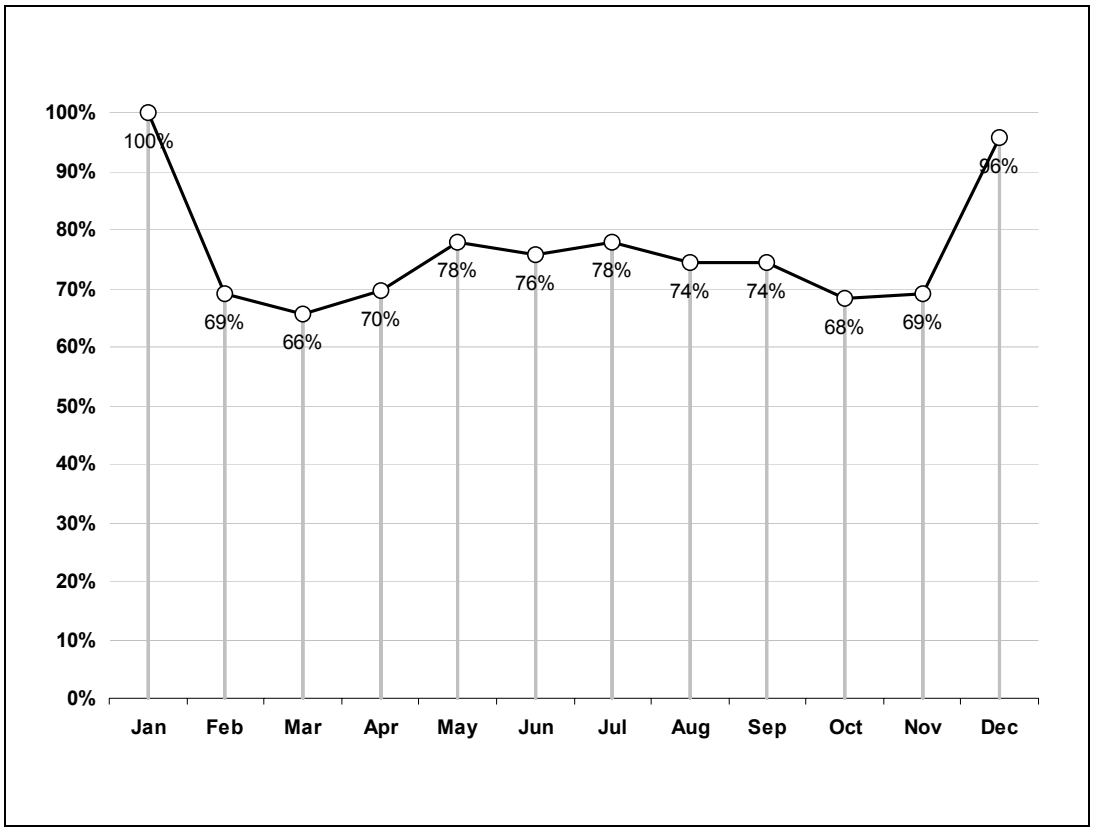



**Figure 34: Monthly Requirements of Heavy Fuel Oil (2003-2004)**

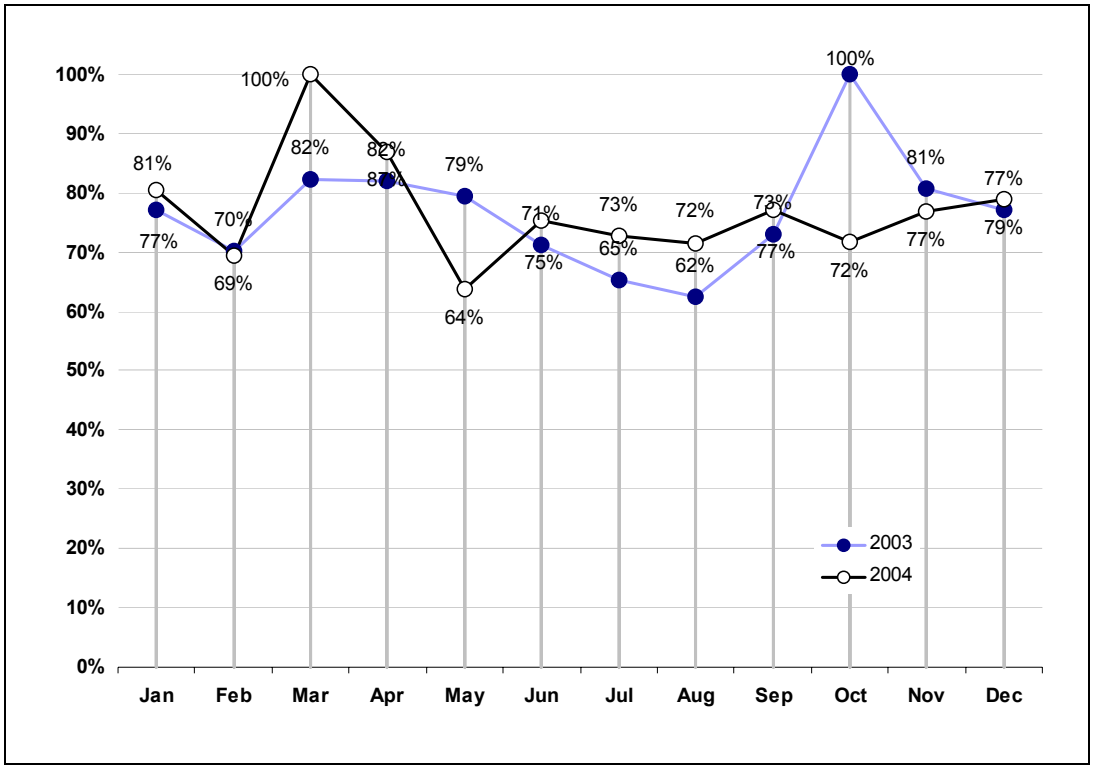



**Figure 35: Monthly Requirements of Diesel (2003-2004)**

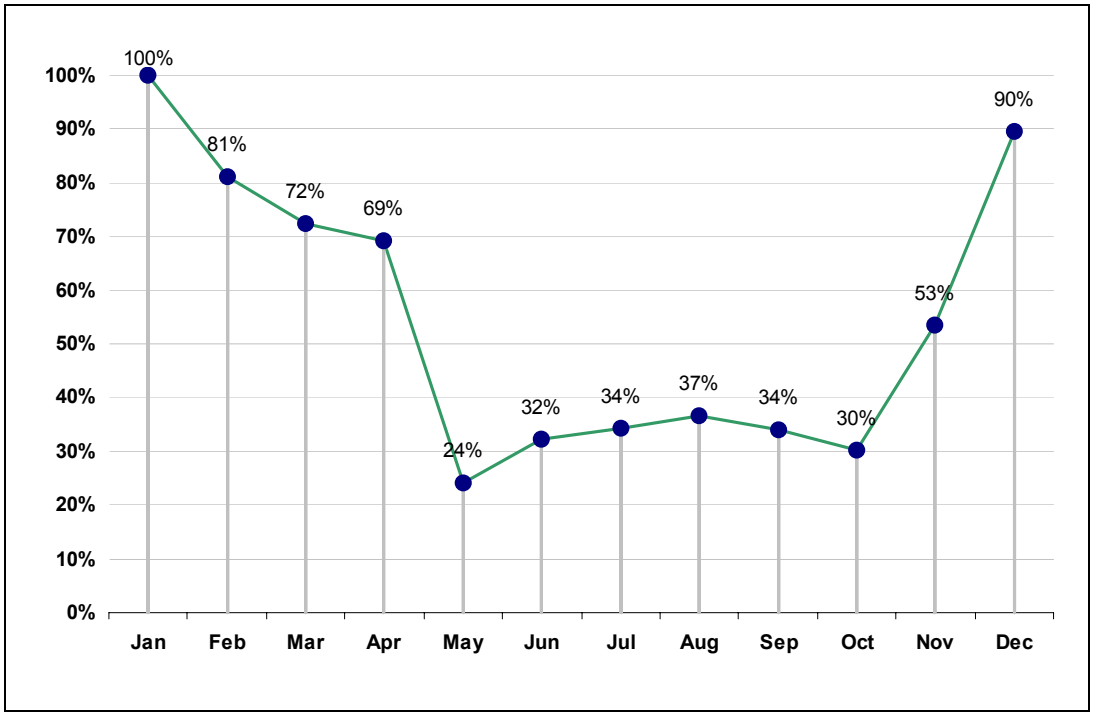



**Figure 36: Monthly Requirements of Jet (2004)**

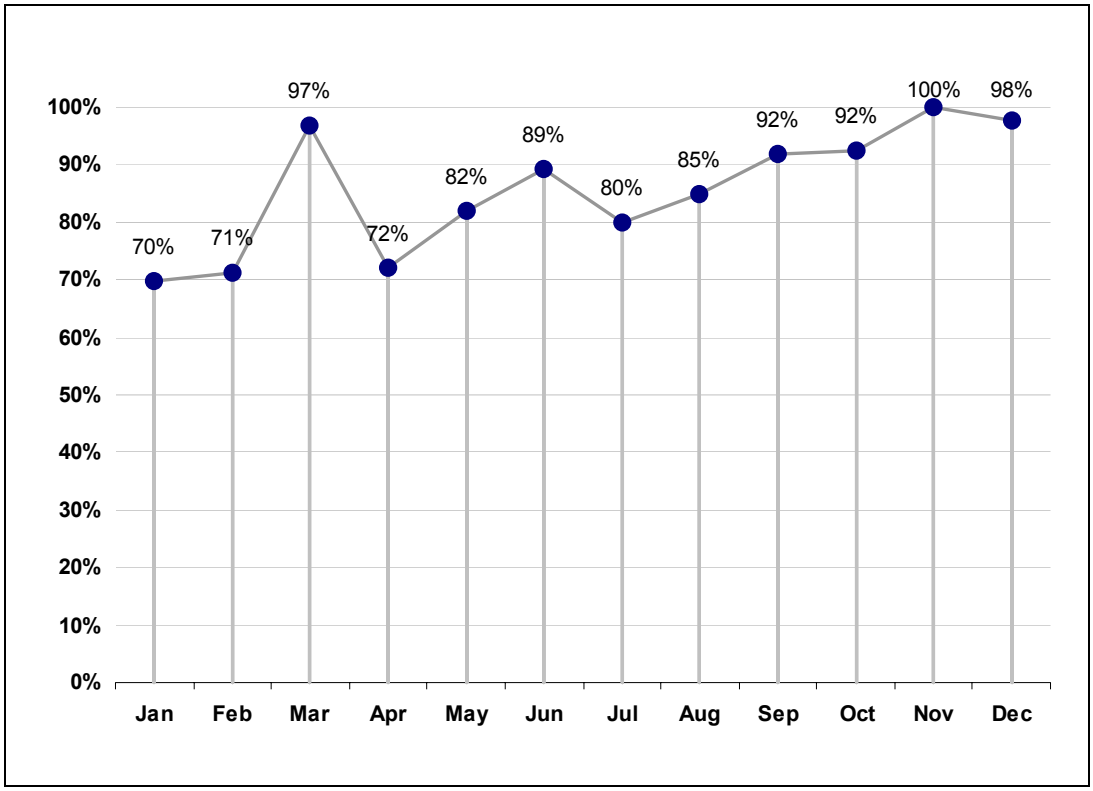



**Figure 37: Monthly Requirements of Gasoline (2004)**

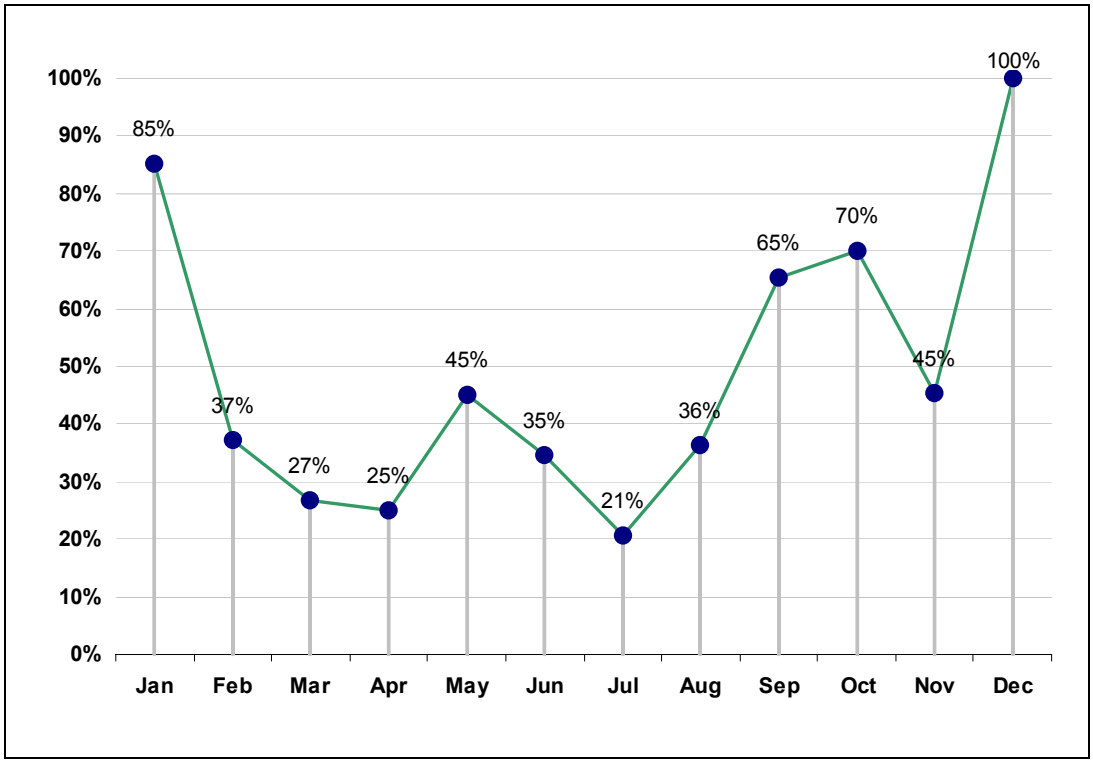



**Figure 38: Monthly Requirements of Kerosene (2004)**

# 6 THE ELECTRICITY CONSUMPTION

The significance of transformation from primary sources (mainly HFO and diesel, and a small proportion of solar radiation) was already described in previous sections. Within this chapter, a more detailed explanation of the situation in the electricity sector will be provided. With regard to the Terms of Reference, the description exclusively deals with the service area of NAWEC, and the consumption characteristics of its grid-connected customers. The description follows the general power supply chain, from power generation over power transmission / distribution to the final end use.

## 6.1 TRANSFORMATION FROM PRIMARY TO SECONDARY ENERGY

In the Greater Banjul Area (GBA), electricity is produced at the Kotu power station by diesel-run generators with a total installed capacity of 46 MW. Table 12 shows the parameters for each unit of the Kotu power station. Commissioning years are between 1981 and 2001. Unit Banjul IC G11 is currently out of operation. The total available capacity amounts to 30.5 MW at present.

Over the period 1995 up to 2004, installed capacity grew from nearly 14 MW to 46 MW. Beside the construction of new units, the retirement of the Yandum 1 and Yandum 2 unit has influenced the development within the nineties. Both units with an installed capacity of 0.75 MW each, were shut down in 1997/1998. Figure 39 present the development of capacity figures in the past. The increase in available generation capacity is corresponding to the consumption of primary energy sources HFO and diesel (compare with section 5.2.1 and 5.2.2).

**Table 12: Installed and Available Capacity in the Greater Banjul Area (2004)**

| Unit | Capacity Installed [MW] | Capacity Available [MW] | Status | Commissioning Year [a] |
|---|---|---|---|---|
| **Total** | **46.0** | **30.5** | | |
| BANJUL IC G01 | 3.0 | 2.0 | OPR | 1981 |
| BANJUL IC G02 | 3.0 | 2.0 | OPR | 1981 |
| BANJUL IC G03 | 3.4 | 2.5 | OPR | 1997 |
| BANJUL IC G04R | 6.4 | 6.0 | OPR | 2001 |
| BANJUL IC G06 | 6.4 | 6.0 | OPR | 1990 |
| BANJUL IC G07 | 6.4 | 6.0 | OPR | 2001 |
| BANJUL IC G08 | 6.4 | 6.0 | OPR | 2001 |
| BANJUL IC G11 | 11.0 | 0.0 | STN | 1997 |

Source: NAWEC 2005

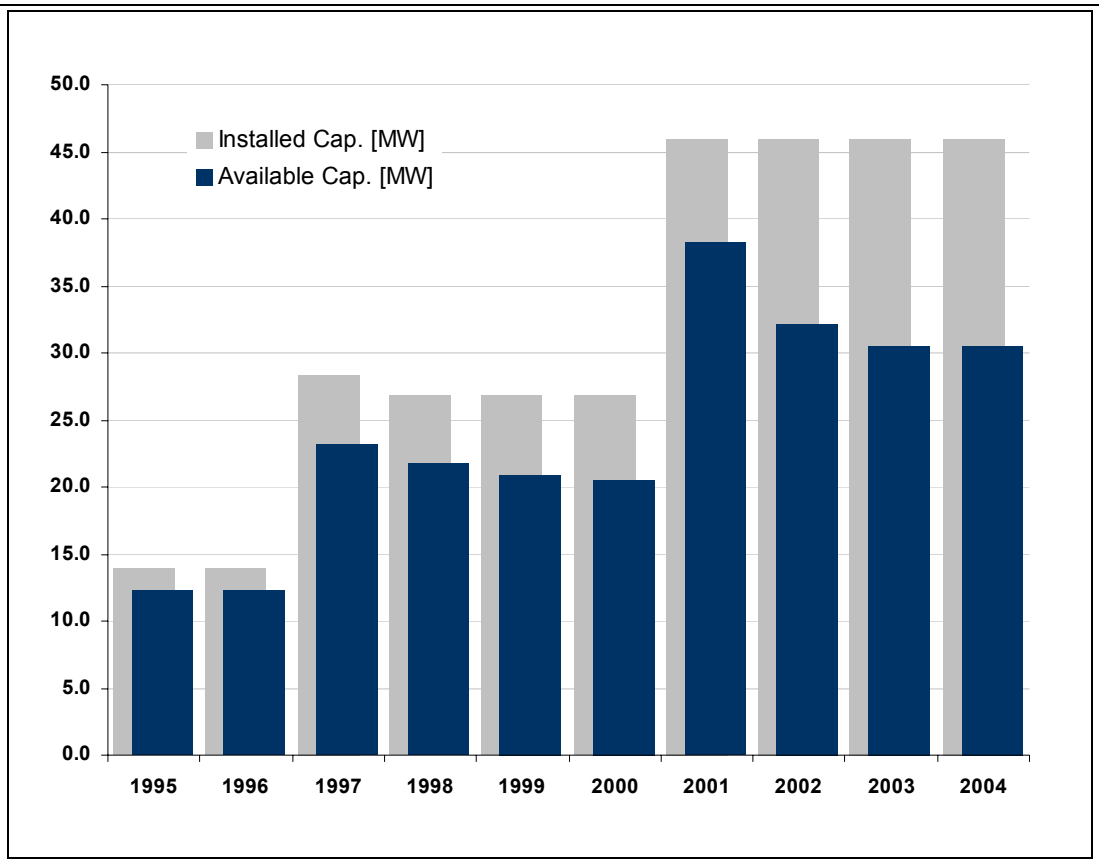



**Figure 39: Development of Installed and Available Capacity (1995-2004)**

Six isolated power stations; located at Mansakonko (400 kW), Farafenni (400 kW), Kerewan (142 kW), Janjangbureh (270 kW), Bansang (420 kW), and Basse (640 kW); supply electricity to areas of The Gambia outside the GBA (rural areas). All the power stations are equipped with diesel-run generators, which, when available, supply electricity for 12 to 15 hours per day to the surrounding areas through low voltage lines (400 V three phase and 230 single phase). In addition, a total of 15 km of 11 kV transmission lines transfer energy from the power stations at Mansakonko, Farafenni, Bansang and Basse to 15 remote transformers from where low voltage lines originate to supply other customers. A project currently under implementation will increase the installed production capacity to 4,260 kW. Table 13 below gives an overview of the scheduled installed capacity of isolated power stations.

Explicitly, despite the imbalance of foreign exchange trading market and the high cost of electricity production, NAWEC robustly committed to enhancing and expanding the coverage electricity services nationwide and aims at increasing the installed capacity to at least 190 MW by 2020. To achieve this objective, an average rate of capacity increase of more than 9 % is required.

**Table 13: Scheduled Installed Capacity in Isolated Service Areas**

| Unit | Capacity Installed [kW] | Capacity Units [kW] | Capacity Fuel Storage [m³] |
|---|---|---|---|
| **Total** | **4,260** | | |
| Barra-Essau | 460 | 2x200kW / 1x60kW | 60 |
| Kerewan | 220 | 1x100kW / 2x60kW | 30 |
| Farafenni | 1,400 | 2x600kW / 1x200kW | 180 |
| Kau-ur | 180 | 3x60kW | 30 |
| Bansang | 600 | 2x200kW | 60 |
| Basse Santa Su | 1,400 | 2x600kW / 1x200kW | 180 |

## 6.2 TRANSPORT OF ELECTRICITY

Over the years, the actual available generation capacity in the Greater Banjul Area could not be effectively transmitted and distributed due to the poor and archaic transmission and distribution network. Two 33 kV transmission lines with a total length of 25 km convey electricity from Kotu to 33 kV / 11 kV substations. Lines at a voltage of 11 kV (total length 181 km) from the substations carry electricity to 11 kV/ 400 V-substations at various locations in the GBA and Brikama. Low voltage lines from the substations distribute electricity to three phase and single-phase consumers at 400 V and 230 V respectively.

The existing Transmission and Distribution System is characterised by acute problems that have become more distinct since the addition of 18 MW in the Kotu power station in the year 2001. Constraint exists in the medium-voltage network in adequately offloading

Power Distribution
Greater Banjul Area's Periphery

End of transmission line
Local Government Area of Brikama

**Figure 40: Electricity supply by NAWEC**

the existing power to the grid. This problem is aggravated by the fact that the majority of the medium voltage feeders are not only overloaded but do contain sub-standard sections which restrict their transmission capacity. The most adverse consequence of these problems is that load shedding is inevitable even when there is sufficient generating capacity at Kotu Power Station. Further, the system was such that any fault of the Transmission / Distribution lines could cause a total collapse of the power network.

In light of this, and in view of NAWEC's commitment to the provision of nationwide electricity supply, the company embarked on a comprehensive and effective rehabilitation, expansion and enhancement of the transmission and distribution networks, known as the "Greater Banjul Area – Transmission and Distribution Network Project". The results of this project are anticipated to effectuate a significant reduction in technical electricity losses and increase system reliability. Table 14 shows the development of losses over the period 1995 to 2004. The compilation includes the annual gross and net generation, as well as the final / billed electricity consumption (including NAWEC's own electricity requirements). The maximum losses occurred in 1997 with a proportion of 40%. It is recognisable, that loss figures varies enormously over the period under consideration. For example, the billed consumption in the year 2003 was 6% less than it was by 2001. On the other side, the annual net generation was 3% higher in 2003 compared with 2001. The overall losses in 2003 amounted to more than 24% and beside technical losses, a significant proportion of non-technical (commercial) losses is indicated.

**Table 14: From Generation to Final Electricity Consumption (1995-2004)**

| Item / Years | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|
| Total Generation [MWh/a] | 83,874 | 84,405 | 109,925 | 118,791 | 128,658 |
| Station Use [MWh/a] | 3,916 | 4,024 | 3,951 | 5,740 | 6,296 |
| Net Generation [MWh/a] | 79,958 | 80,381 | 105,974 | 113,051 | 122,362 |
| Billed Consumption[MWh/a] | 56,830 | 48,691 | 62,003 | 74,750 | 92,382 |
| Total Losses [MWh/a] | 23,128 | 31,690 | 43,971 | 38,301 | 29,980 |
| Total Losses [%] | 27.6% | 37.5% | 40.0% | 32.2% | 23.3% |

| Item / Years | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Total Generation [MWh/a] | 116,907 | 146,859 | 163,062 | 150,307 | 128,061 |
| Station Use [MWh/a] | 6,043 | 6,302 | 2,697 | 5,958 | 2,644 |
| Net Generation [MWh/a] | 110,864 | 140,557 | 160,365 | 144,349 | 125,417 |
| Billed Consumption[MWh/a] | 90,714 | 114,615 | 128,347 | 107,718 | 93,334 |
| Total Losses [MWh/a] | 20,150 | 25,942 | 32,018 | 36,631 | 32,083 |
| Total Losses [%] | 17.2% | 17.7% | 19.6% | 24.4% | 25.1% |

## 6.3 FINAL CONSUMPTION OF ELECTRICITY

The Gambia has over the last decades witnessed a rapid population, infrastructural and business expansion, triggering a correspondingly rising demand in the generation and transmission of electricity. Due to the poor state of transmission and distribution networks, the magnitude of the demand has exceedingly outstretched the available installed capacity, thus culminating in the re-occurrence of frequent maintenance intervals and continuous load shedding. Therefore, the historical and present billed electricity demand figures cannot reflect the actual requirements of NAWEC's customers. Peak and annual demand figures, registered by NAWEC extremely depend on capability of the transmission and generation side, and in particular on available capacity and fuel delivery.

Figure 41 provides the development of net-generation and billed consumption in recent years. In 2004 the final consumption amounted to 93,334 MWh/a. NAWEC, currently under the purview of the Office of the President should, ideally, meet the needs of up to 100,000 customers. As provided by the utility's commercial division, at present the total number of electricity customers amounts to only 35,270 (December 2004). No significant change was registered compared with the figures of the preceding year. The total customer number (including water supply) grew by only 3 % from 52,400 (by the end of 2003) to 54,000 (by the end of 2004). The customer base within the provinces with some 2,700 is also low. Beside these clients (mainly from the residential sector) the isolated

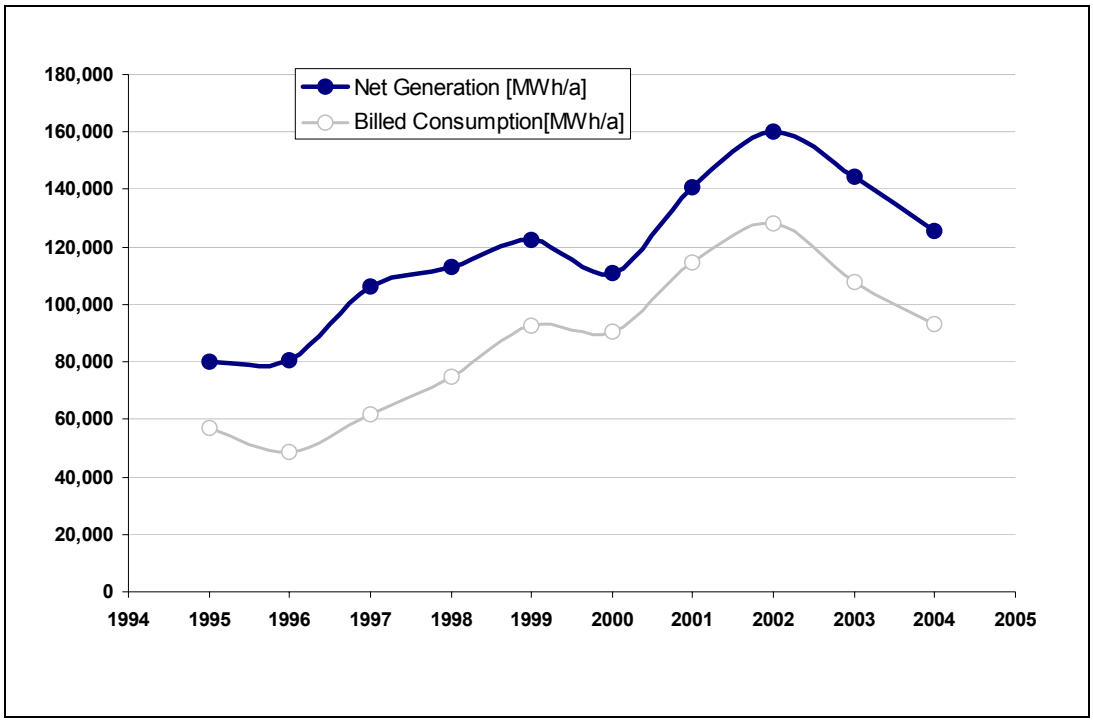



**Figure 41: Development of Net Generation and Billed Consumption (1995-2004)**

power stations supply the water reticulation systems in Basse, Bansang, Jangjanbureh, Mansakonko, Farafenni and Kerewan.

Based on the population and household figures, discussed in detail in chapter 3 “The Demography of the Gambia”, the present electrification rate can be calculated as follows. Within the Greater Banjul Area (Capital Banjul and Kanifing) the electrification rate represents 50.1%. Countrywide the rate of access to electricity supplied by NAWEC stands at 19.4%.

The annual electricity consumption per customer group is provided in Table 15. By the end of the nineties, the utility launched the pre-payment “Cash Power” programme to reduce non-payment of bills and to address the issue of non-technical losses. The so-called “maximum demand” in NAWEC’s statistics are larger commercial and industrial clients (e.g. supermarkets, hotels and telecommunication companies).

**Table 15: Final Consumption by Customer Groups (1995-2004)**

| Final Consumption [MWh/a] / Year | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|
| Domestic | 28,278 | 26,985 | 29,911 | 37,463 | 48,851 |
| Commercial | 15,409 | 11,907 | 16,551 | 16,235 | 16,231 |
| Maximum Demand | 6,783 | 5,077 | 9,191 | 11,181 | 10,820 |
| Agriculture | 1 | 2 | 1 | 7 | 13 |
| Local Authority | 291 | 389 | 441 | 462 | 504 |
| Central Government | 6,068 | 4,331 | 5,908 | 6,282 | 6,982 |
| Prepayment Domestic | | | | | |
| Prepayment Commercial | | | | | |
| Prepayment Maximum Demand | | | | | |
| Own Use | | | | 3,120 | 8,981 |
| **TOTAL** | **56,830** | **48,691** | **62,003** | **74,750** | **92,382** |

| Final Consumption [MWh/a] / Year | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Domestic | 45,676 | 55,118 | 61,887 | 48,684 | 38,833 |
| Commercial | 14,362 | 16,902 | 15,957 | 9,013 | 7,771 |
| Maximum Demand | 9,467 | 12,859 | 17,237 | 25,122 | 26,151 |
| Agriculture | 39 | 58 | 64 | 6 | 4 |
| Local Authority | 841 | 740 | 507 | 389 | 279 |
| Central Government | 7,168 | 8,796 | 8,974 | 7,076 | 7,195 |
| Prepayment Domestic | 1,030 | 4,028 | 6,119 | 6,403 | 4,864 |
| Prepayment Commercial | 1,046 | 3,448 | 4,336 | 2,929 | 1,983 |
| Prepayment Maximum Demand | 1,046 | 3,448 | 4,336 | 1,202 | 780 |
| Own Use | 10,039 | 9,218 | 8,930 | 6,894 | 5,474 |
| **TOTAL** | **90,714** | **114,615** | **128,347** | **107,718** | **93,334** |

Source: Commercial Division – NAWEC 2005

### 6.3.1 Sector Break Down

Nearly half of the annual electricity consumption in NAWEC's service area is caused by the Gambia's residential sector (see Figure 42). The group of large (mainly industrial) customers comprises almost a third and the commercial sector contributes some 11% of the billed consumption. The institutional sector (including local authorities and central government) ranks on fourth place with some 8.5%. Almost negligible is the requirement of the agricultural sector. As shown in the previous Table 15, agriculture's consumption dropped from its maximum value of 64 MWh/a in 2002 to only 4 MWh/a in 2004. This decrease is in particular the result of the constantly diminishing agricultural crop land in the Greater Banjul Area. In 2004, the proportion of agricultural consumption amounted only 0.01%.

Based on customer numbers and annual electricity consumption figures the present specific consumption (also called energy intensity) was calculated. Approximately 2,500 kWh is consumed as an average by each customer per year. The group of large (mainly industrial) customers represent the highest intensity with more than 26,900 kWh/(a,C), followed by the institutional sector with nearly 7,500 kWh/(a,C), and the institutional sector with some 4,700 kWh/(a,C). While intensity within the agricultural sector is less than 500 kWh/(a,C), one household client consumes an average of 1,490 kWh/a. Related to the entire population number, the final electricity consumption is less than 63 kWh per capita and year. The Gambia belongs to those countries with the lowest per-capita-electricity consumption. Annex 8 provides an Africa-wide comparison concerning this matter.

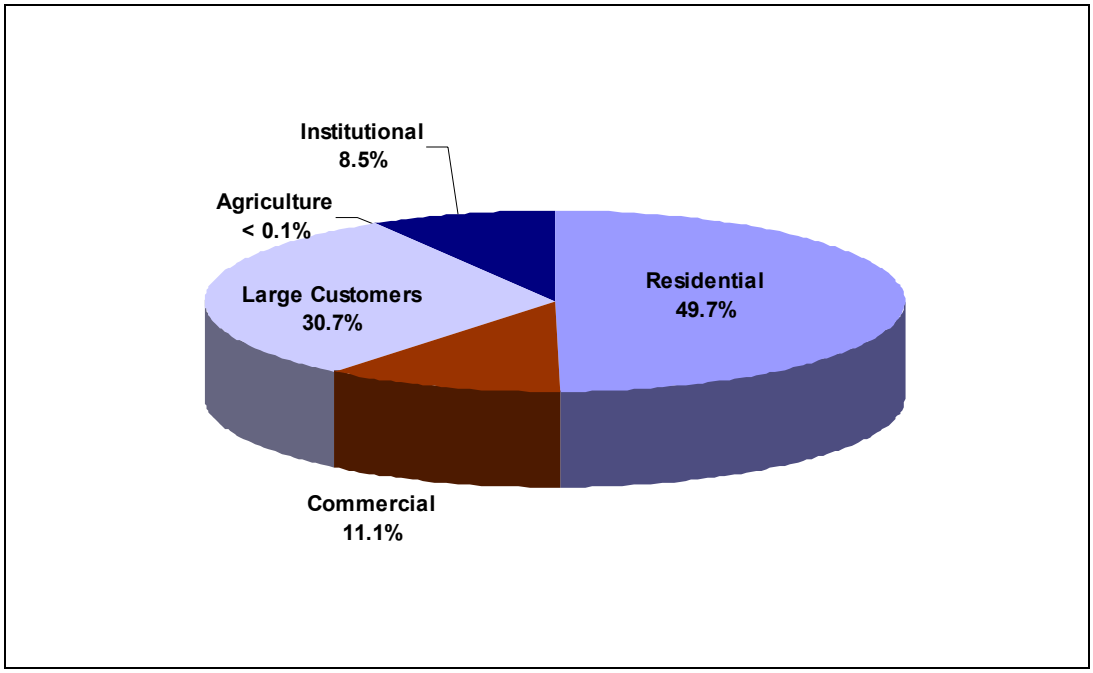



**Figure 42: Sector Break Down of Electricity Consumption (2004)**

### 6.3.2 Seasonal Characteristics and Suppressed Demand

As already mentioned, the actual available generating capacity defines / limits the peak and overall consumption of NAWEC customers. The following figure shows the consumption pattern for each customer group over the year 2004. Due to its very low consumption, the agricultural sector is not illustrated separately. Monthly electricity consumption in this sector varies between only 200 kWh/mon and 500 kWh/mon.

As stated by NAWEC currently some 10 MW is load-shed on an average basis. In 2004, the available capacity amounted to 30.5 MW. There is also around 45 MW of private generation capacity associated in particular with hotels and industry. The peak demand which was recorded in December 2004 amounted to 25.2 MW (see Table 16). Taking into account the suppressed demand due to load-shedding, self-generation and transport capacity constraints, a revised maximum power demand as at today is close to 60 MW.

**Table 16: Comparison of Recorded Peak Load and Available Capacity**

| Capacity | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Peak Load [MW] | 20.1 | 25.2 | 27.3 | 25.9 | 25.2 |
| Date recorded | 20-Jan | 19-Nov | 25-Feb | 12-Dec | 23-Dec |
| Available Cap. [MW] | 20.5 | 38.2 | 32.2 | 30.5 | 30.5 |

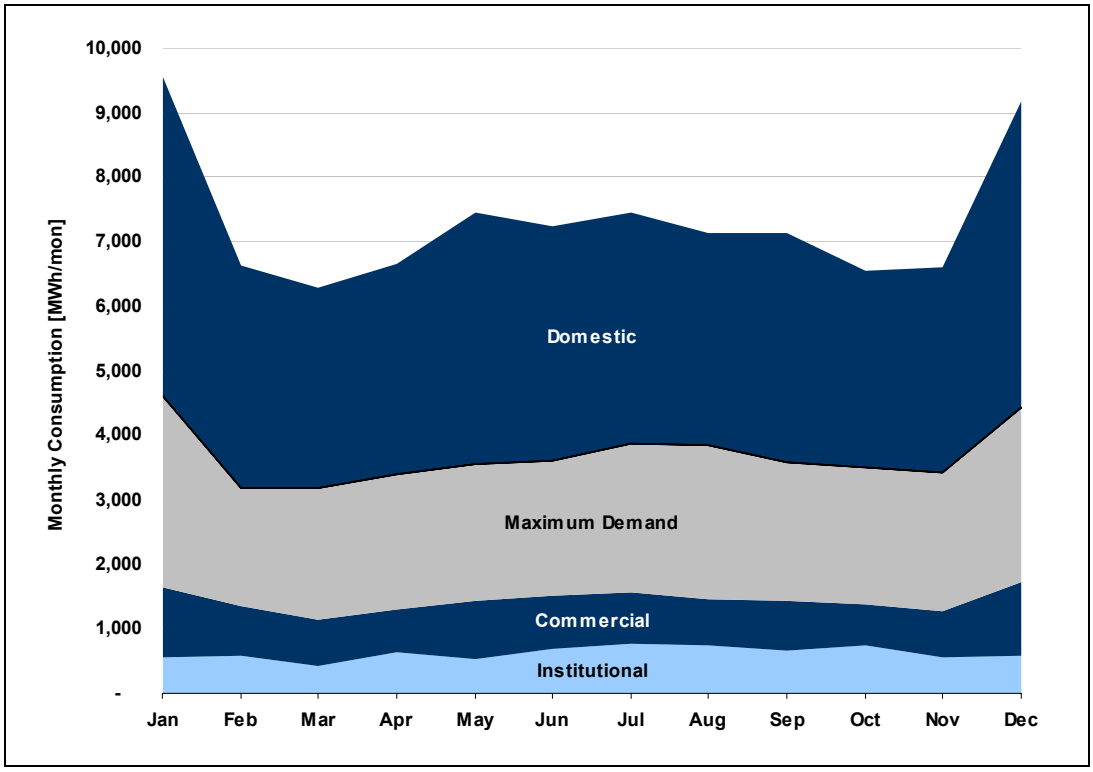



**Figure 43: Monthly Electricity Consumption Characteristics per Sector (2004)**

The entire annual electricity demand at power plants' sent-out level is estimated by NAWEC at 289 GWh/a in 2004. This figure the actual served demand plus the suppressed demand over the period of one year. The comparison of this figure with the actual net generation of some 125 GWh/a (see Table 14) shows, that more than the double of NAWEC's plants' output is needed, to address the electricity demand (including technical and non-technical losses) within the service area.

The residential sector is that sector, which is mostly affected by load-shedding. As usual, some of the other customer groups are supplied with priority. Nearly not affected by load-shedding is the institutional sector. Consumption figures of that sector can represent soonest the actual requirements of this customer group.

While Annex 9 provides an insight into the monthly characteristics of all sectors, the institutional sector pattern is extracted in Figure 44. A comparison of monthly consumption and average temperatures per month was carried out. Due to the use of air-conditioners in the institutional sector, logically the consumption trend[5] follows mainly the trend of average temperatures over the year. Some divergences were observed, which

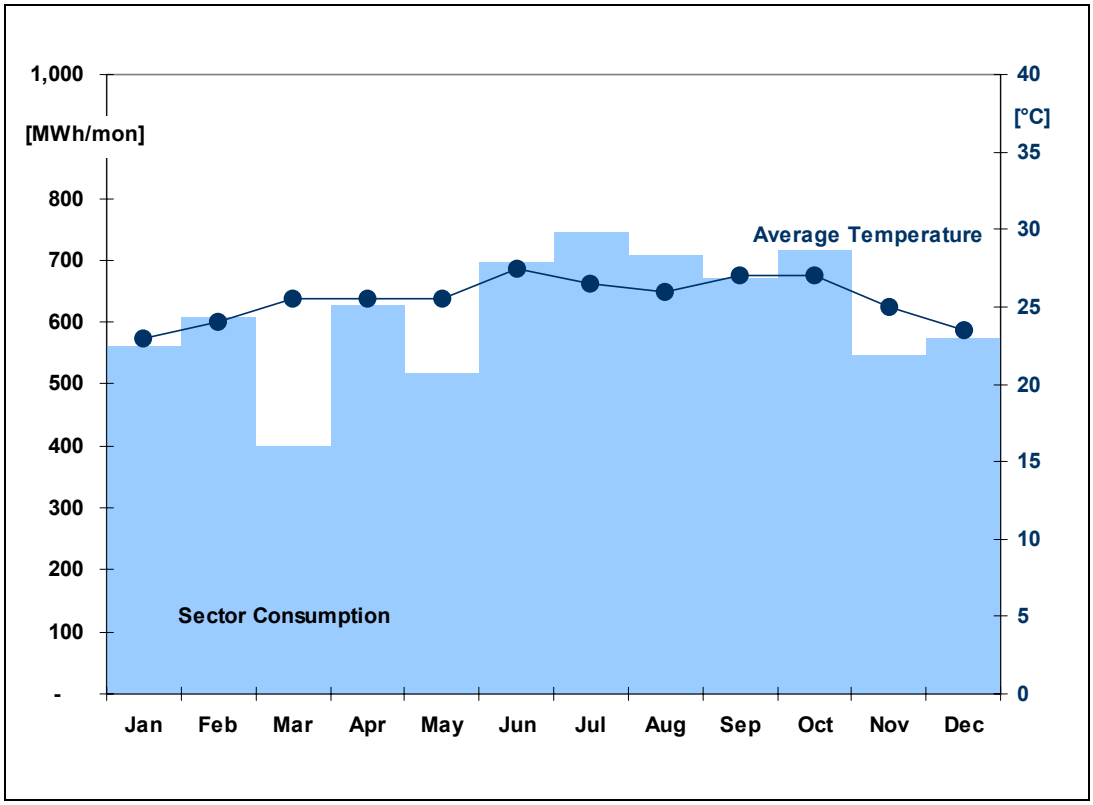



**Figure 44: Electricity Consumption of the Institutional Sector and Average Temperature**

[5] Within the graph, monthly consumption figures were adjusted.
The different number of days per month was taken into account.

can be caused by digressive temperatures or other impacts on customers' typical consumption behaviour (e.g. Ramadan period). Nevertheless, consolidated findings for only one sector cannot be transferred to other customer groups; and cannot provide a sound standing picture of daily / monthly or seasonal characteristics of the entire demand side. The dimension of load shedding in the Gambia's electricity sector does not allow any well-founded description of customers consumption characteristics over selected time periods. Concerning this matter some general traits of major customer groups and their impact to demand characteristics will be discussed in the following.

The ***residential sector*** is defined as private household establishments that consume energy primarily for air conditioning, lighting, refrigeration, water heating, cooking, and telecommunication. Type and number of electrical devices applied in private households depend on customer's financial position, customer's habits as well as climatic conditions. Power demand of the residential sector is characterised by most constant annual growth rates and can possess highest seasonal fluctuations (e.g. due to climatic conditions, number of daylight hours). In many cases, the load of the residential sector is responsible for significant seasonal variation in system's total peak and monthly energy demand.

The ***commercial sector*** is generally defined as non-manufacturing business establishments, including wholesale businesses and retail stores. During working days, the commercial sector can cause seasonal fluctuations in particular due to the use of air conditioning. The sectors contribution to system's peak demand during evening hours is low (due to opening hours of commercial establishments). The consumption characteristics of customers within the ***institutional sector*** is similar. This sector comprises governmental institutions, local authorities, educational establishments, but also hospitals and health centres.

The ***industrial sector*** is generally defined as manufacturing, construction and mining, establishments. In several cases, the industrial sector includes also agriculture, fishing or forestry. It was observed by the Consultant, that several statistics in the Gambia (e.g. NAWEC's billing statistics) allocated the tourism branch (e.g. hotels, motels, restaurants) to the industrial sector. This fact should be mentioned in terms of sector-specific statements. The electricity demand of the industrial sector is considered primary as base load that contains little weather dependent variation.

# 7 THE ENERGY BALANCE OF THE GAMBIA

This section summarises the results within the frame of the assessment of the utilisation of primary and secondary energy sources in the Gambia. The energy balance comprises the entire supply chain, beginning from domestic and imported energy sources, over transformation and transport processes to the final consumption by source and sector. The balance is presented in form of a Sankey diagram (energy-flow-diagram) which is presented in Figure 45, and considers the following items:

**Input**

The input considers the primary energy sources applied in the Gambian energy system. It is divided into the both types, imported and domestic sources. While imported energy sources are in particular petroleum products, domestic primary energy sources are fuelwood and a small proportion of solar radiation. It has to be borne in mind, that the energy balance shows the actual amount of energy use by source, and not any potential estimates.

**Throughput**

Within the balance, any process of transformation of energy is mentioned as throughput. Transformation processes concerning especially the generation of electricity on the basis of fuels or solar radiation. Furthermore, electricity needs to be supplied finally at low-voltage level to the end user. The throughput also deals with transmission and distribution, as well as with transformation processes from higher voltage levels.

**Output**

The output considers the final energy consumption. It is divided into the major customer sectors, such as the residential sector, agriculture, industry, transport /aviation and the commercial/institutional sector. Beside this sector classification, each primary or secondary energy source is analysed by its final utilisation share.

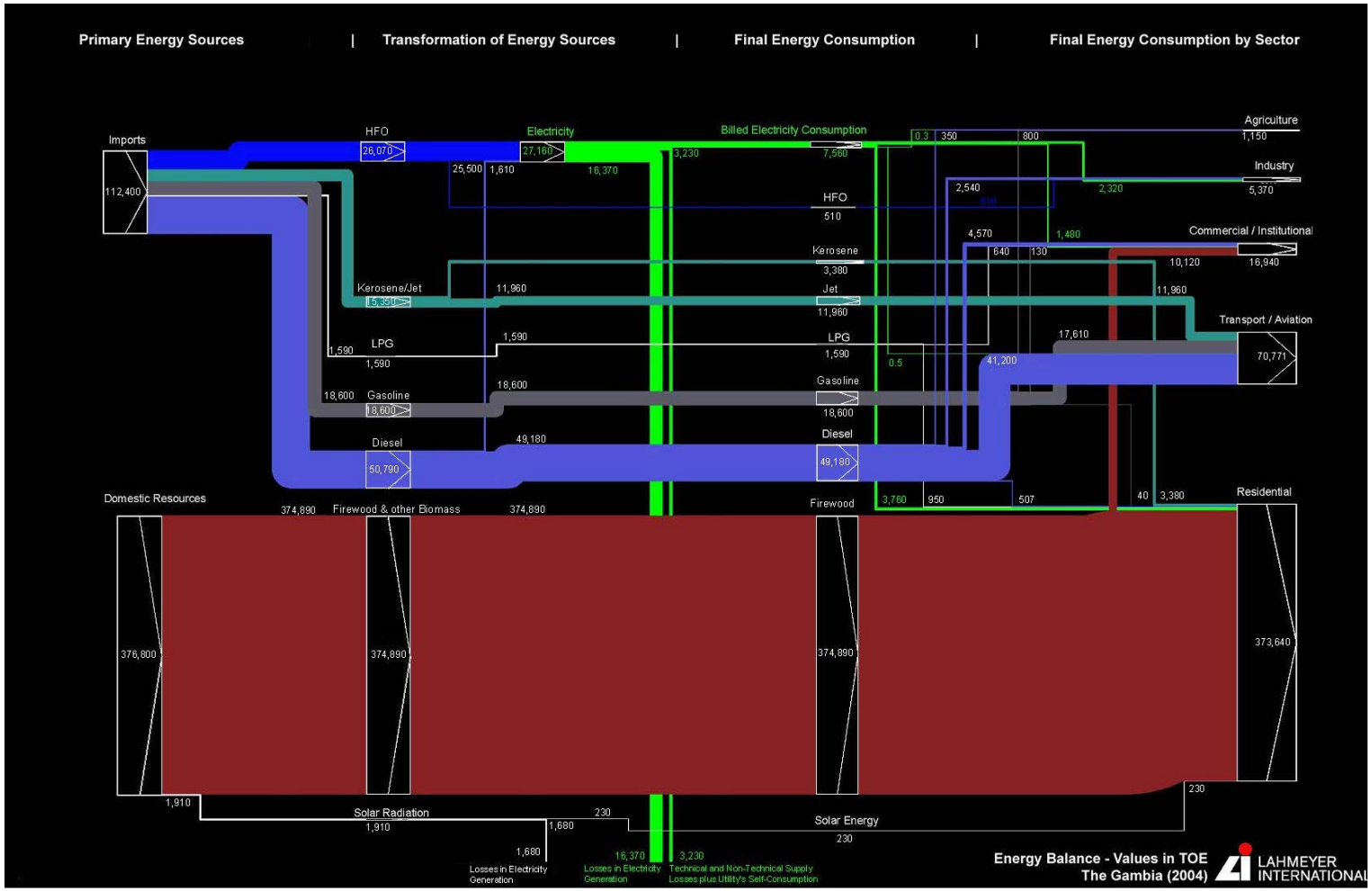



**Figure 45: Energy Balance in TOE/a (2004)**

# 8 PROJECTION OF PRIMARY AND SECONDARY ENERGY

The energy demand forecast is an essential prerequisite for planning activities, in particular for energy supply system expansions and the substitution of one energy source by another. If projected demand levels are too low, serious adverse economic consequences for consumers and the economy at large could occur. If projected demand levels are too high, excess resources can impose undue financial hardships on suppliers and their consumers. In addition, this situation results in unnecessary and high economic opportunity costs associated with resource misallocation.

As described in the previous chapter, analyses of nation-wide energy consumption need to consider transformation processes, different purposes in terms of the final energy use, as well as characteristics of individual customer groups. Trends in energy consumption over the past ten to fifteen years were evaluated, the main determinants such as population growth, living conditions and (macro-)economic developments were analysed in detail. The following sections provide the projection of future energy requirements in the Gambia. First, an insight into the methodology and assumptions applied is provided.

## 8.1 FORECAST APPROACH

There exist two main approaches in terms of forecasting the future electricity demand: the Bottom-Up approach, and the Top-Down approach. In general, the ***Bottom-Up*** approach considers the country's major customer groups, such as the residential, commercial/institutional and industrial sector. The approach is mainly based on field investigations and surveys. Data and information were gathered from:

- Interviews / inspections of individual customers,
- Assessments of typical, representative customers of several consumer groups (e.g. poor, standard and rich household customers),
- Information from associations of branches,
- Statistics of utility's / suppliers and governmental institutions,
- Discussions with decision makers.

The Bottom-Up approach considers specific characteristics and developments of individual customer groups and can be applied for very detailed forecast studies, which provide projections including sectoral, but also regional classifications. Beside this advantage compared to the Top-Down approach, it can contribute strongly to the improvement of the utility's, supplier's or institution's overall sector knowledge and strategic decision-making process.

Publications of the Gambia's Department of State for Finance and Economic Affairs gives a clear picture of former and expected future (macro-)economic development of the country. Economic Indicators such as the Gross Domestic Product are typical Top-Down

forecast components. Generally, the ***Top-Down*** approach considers a projection for the major consumer classes (at least residential, commercial and industrial sector) to arrive at a nation-wide forecast level. The proceeding is based on the assessment of economic and energy related data such as:

- The Gross Domestic Product (GDP), historical values, current value and future development,
- The GDP proportion of selected sectors (mainly the industrial sector),
- Energy related indicators (e.g. electricity intensity = electricity consumption / GDP by branch or sector).

Furthermore, demographic data (population number, historical and future growth rate) needs to be evaluated, general previous trends of energy consumption identified and political preferences and objectives considered. The advantage compared to the Bottom-Up approach is the lower number of input data and input assumptions, and in relation to that, the lower effort for data gathering, calculation and forecast modelling. On the other side, the main disadvantages are the limited applicability and the dependence on other forecasts, such as projections in terms of country's economic and demographic development. Usually the Top-Down approach is only applicable for nation-wide forecasts without any regional diversification. Developments for main customer sectors can be projected, more detailed and specific prognosis can hardly be established.

To provide most realistic results within this study, the methodology applied is based on a mix between both approaches. It includes a strong analytical component, but also takes into account selected (macro-)economic indicators, which is possible due to the stable and growing economy of the Republic of the Gambia. The assessment and projection results in this study provide the base for the investigation of possible alternatives to the current energy consumption structure, in order to achieve economic gains in terms of poverty reduction, sustainable development and efficient allocation.

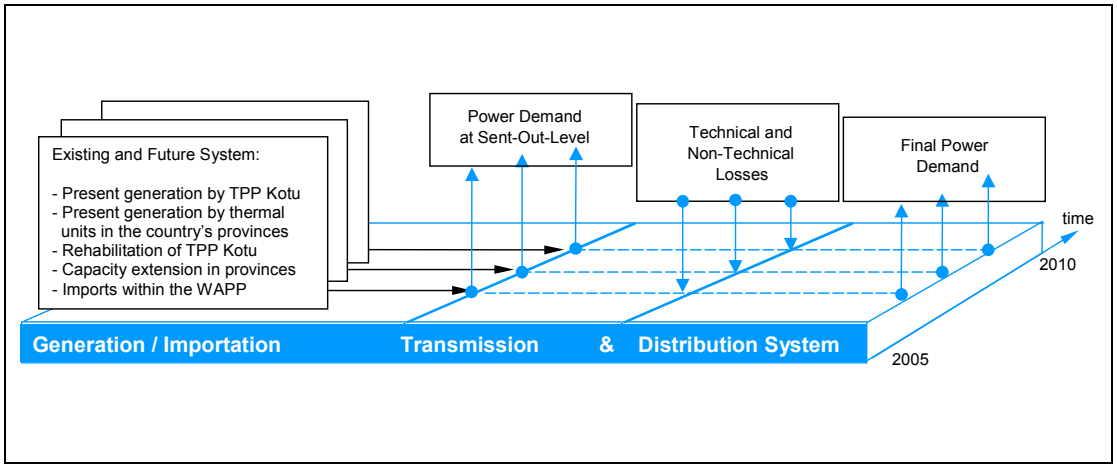



**Figure 46: Supply Chain – From Electricity Sent-Out to Final Demand**

The history and the present situation show that many significant regional differences in energy consumption characteristics exist in the Gambia. Household sizes, as well as energy types and consumption figures per household differ strongly within the frame of comparison from province to province and from urban and rural areas. Currently the institutional, commercial, industrial and transport sector is concentrated around Banjul. To provide a comprehensive data base, the Consultant has decided to establish a regional break down of future requirements of energy sources. This approach exceeds the given tasks of the Terms of Reference, but is estimated as an essential additional input information for the later identification of renewable energy supply options. The following regions / LGA are considered within the several energy forecasts:

- Greater Banjul Area,
- LGA of Brikama,
- LGA of Mansakonko,
- LGA of Kerewan,
- LGA of Kuntaur,
- LGA of Janjanbureh,
- LGA of Basse.

A particular significance has the forecast of the Gambia's electricity demand. As shown in the Energy Balance in Chapter 7, the generation of electricity is the major transformation process from primary to secondary energy sources. This means that any increase of conventional primary energy based power generation will have a direct impact to the annual consumption of petroleum products, such as heavy fuel oil and diesel. On the other hand, an increase of power generation would decrease the high proportion of suppressed electricity demand and therefore the use of primary energy sources for self-generation (in particular diesel). Furthermore, a higher electricity access rate will lead to the situation, that currently used energy sources (e.g. for lighting) will lose their significance in the future due to their substitution with electricity.

Not only the present and expected future suppressed demand is considered within the electricity demand forecast. In addition, the consultant has reproduced the entire power supply chain beginning from generation, over transportation (transmission and distribution), and ending at the final (billed) consumption. Figure 46 displays the main parts considered within the entire supply chain. Major future projects at the supply side (short- and middle term until 2010/2011) are:

- The increase of available capacity in the existing generation system of GBA, in particular due to the rehabilitation of Kotu TPP's units, and in particular the start of operation of unit G11 with an installed capacity of 11 MW (compare to section 6.1 "Transformation from Primary to Secondary Energy", Table 12).

- The start of operation of the heavy fuel oil fired Brikama IPP station with an implementation period of 2005 / 2007 and a total installed capacity of 30 MW,
- The increase of available capacity in isolated service areas, in particular due to the construction of several diesel fired units with capacities between 60 kW, and 600 kW (compare to section 6.1 “Transformation from Primary to Secondary Energy”, Table 13),
- The active participation in electricity trade as member of the West Africa Power Pool (The following Table 17 illustrates actual estimates for the future electricity import of the Gambia).

Beside the rehabilitation and extension of the existing transmission and distribution grid, the national utility has to undertake suitable measures to reduce the present high losses level, caused by technical, but also non-technical (commercial) losses. Within the forecast a step-wise reduction from currently more than 25% to 10% is considered.

In the following paragraphs, the main assumptions and input data for the forecasts will be explained. The first fundamental forecast component is the projection of the demographic development. Population, household sized and numbers were evaluated separately for each region to arrive at nation-wide level by cumulating the individual regional results. The

**Table 17: Expected Electricity Trade of the Gambia (2005-2014)**

| Period | Imports | Exports |
|---|---|---|
| **2005-2006** | 0 | 0 |
| **2007-2008** | 0 | 0 |
| **2009-2010** | **235 GWh/a (Senegal)** | 0 |
| **2011-2012** | **269 GWh/a (Senegal)** | 0 |
| **2013-2014** | **303 GWh/a (Senegal)** | 0 |

Source: West Africa Regional Transmission Project, 2004

input data for the projection of demographic development is mainly based on historical trends within the inter-census periods. It includes:

- The annual change rate of population number in each region,
- A diversification in population numbers in rural and urban areas, which allows a projection of future urbanisation tendencies,
- The nation-wide average household size,
- The change rates of household sizes,
- The derivation of urban (and related to this, rural) household sizes of the several regions from nation-wide average.

The results of this forecast component are in many cases important import data for other projections in terms of the future requirements of energy sources. The entire projection is described in Annex D.0. Other input data than population numbers, to forecast the several primary energy sources are:

- The annual growth rate of the gross domestic product in general,
- The annual growth rate of the gross domestic product of the regarding sectors,
- The break down of energy demand by sector,
- The correlation between annual changes of the gross domestic product and the related annual change of energy applied within the individual sectors,
- General energy intensity (specific consumption) figures, and in selected cases an indexation of intensity over the period under consideration.

In general, the forecasts consider the twenty-years-period 2005-2025. Except the forecast of demographic development, the base year in all calculations is 2004. Because of its derivation, the national census in 2003, the base year for the population projection is the year 2003.

Basically, the electricity forecast follows the procedures described above. Due to its rather complex structure, separate projections are provided, such as the demand at sent-out level and the final demand at end user level (compare with Figure 46). In order to consider the suppressed electricity demand, an adjusted sector break down was applied, which considers not only the billed electricity consumption, but also the presently unserved electricity demand.

## 8.2 FORECAST RESULTS

This section describes the results of the demand forecast for the different energy sources until 2025. All detailed figures of the projection are provided in form of tables in Annex D. Beside the expected development of energy demand, it includes also the projection of the demographic development in the Gambia.

### 8.2.1 Projected Fuelwood Demand

The demand forecast for fuelwood in the Gambia expects a slightly increasing development for the period under consideration, i.e. 2005-2025. However, it can be observed, that the average annual growth rates decline in the course of the period. Whereas the projected annual average growth rates are 3.6% for the period from the base year 2004 until 2010 and 2.0% for 2010-2015, before there is a slight decrease between 0.7% and 0.8% average annual growth for 2016-2025. It should be borne in mind that the projection of fuelwood consumption strongly depends on the demographic development. Fuelwood will keep its dominating role as energy source for cooking purposes over the short- and mid-term period. The decrease in annual growth rates figures (in particular within the long-term period) can be ascribed to the changes in population numbers and respectively in the number of households. Furthermore, the assumed reduction of energy intensity to 85% influences the demand figures especially over the period 2016-2025. Table 18 provides the figures of the forecasted fuelwood demand per region, whereas it is also visualised in Figure 47, which presents a regional break down. Fuelwood is utilised in the residential and in the commercial/institutional sector. The increase in demand is higher in the residential sector during the first decade of the demand forecast period: The projected demand results in an average annual growth rate of 5.2% for the residential sector and 2.9% for the commercial/institutional sector from the base year on until 2015. For the second decade however, the annual average growth is 0.7% for both sectors. A detailed break-down of the fuelwood demand forecast in total, per sector and per region is displayed in Annex D.1.

**Table 18: Fuelwood Demand Projection in TOE/a (2004-2025)**

| Entire Fuelwood Demand | | | | | | |
|---|---|---|---|---|---|---|
| | | Base >> | 2010 | 2015 | 2020 | 2025 |
| **Total Annual Demand** | **TOE/a** | **367,747** | **454,356** | **502,225** | **519,048** | **539,326** |
| GBA - GREATER BANJUL AREA | TOE/a | 95,989 | 116,374 | 126,533 | 132,010 | 137,798 |
| LGA OF BRIKAMA | TOE/a | 104,494 | 152,374 | 185,483 | 195,374 | 207,555 |
| LGA OF MANSAKONKO | TOE/a | 19,655 | 21,147 | 21,149 | 20,914 | 20,699 |
| LGA OF KEREWAN | TOE/a | 46,854 | 50,258 | 50,110 | 48,549 | 47,038 |
| LGA OF KUNTAUR | TOE/a | 21,549 | 23,880 | 24,343 | 24,140 | 23,943 |
| LGA OF JANJANBUREH | TOE/a | 29,270 | 34,262 | 36,890 | 39,324 | 42,449 |
| LGA OF BASSE | TOE/a | 49,936 | 56,060 | 57,718 | 58,736 | 59,845 |

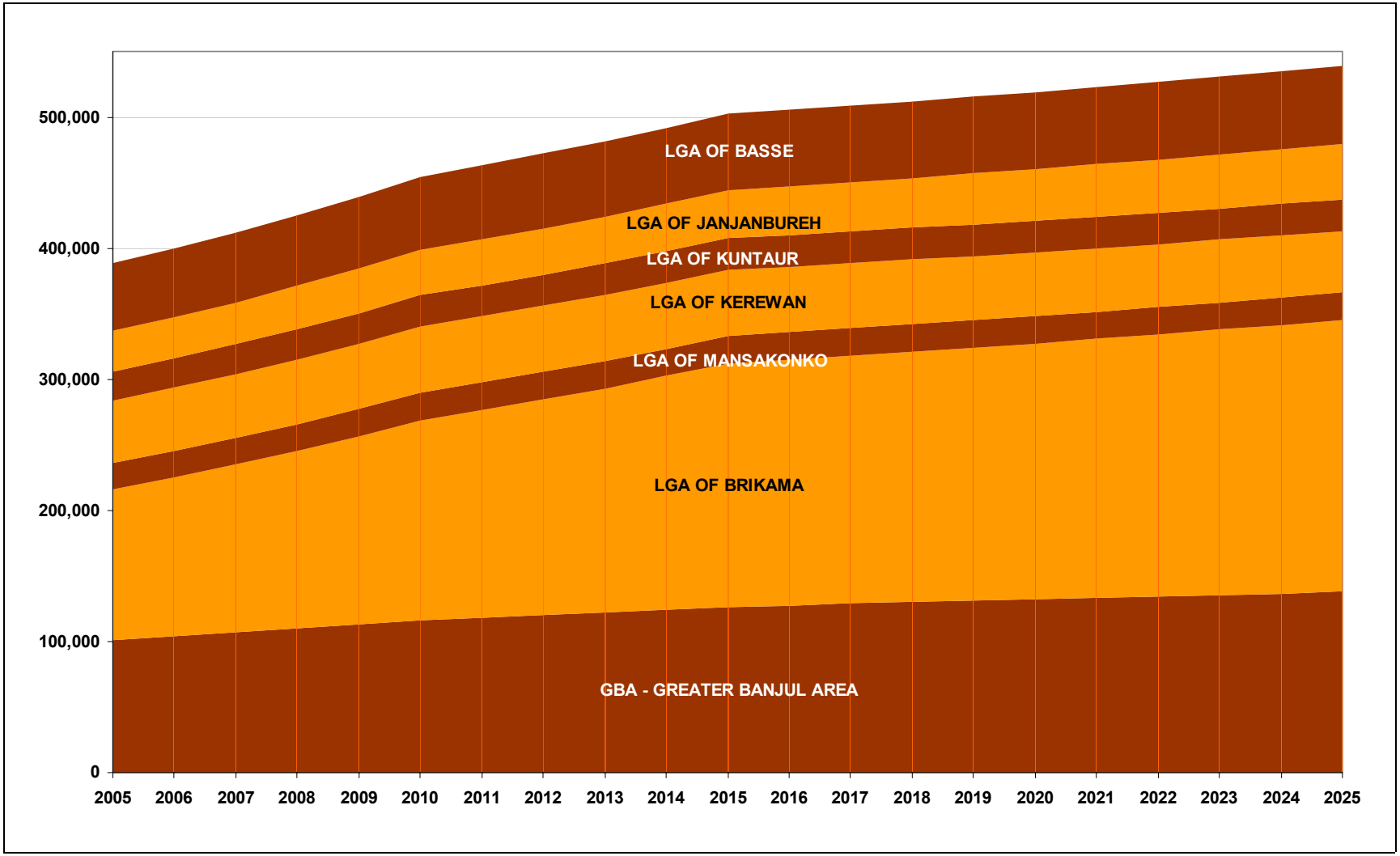



**Figure 47: Projected Fuelwood Demand in TOE/a (2005-2025)**

### 8.2.2 Projected Diesel Demand

Apart from a decline in 2010-2011, the overall diesel demand in the Gambia is expected to increase during the considered period 2005-2025, but especially at the end of this period. This arises both from Table 19 and Figure 48. The expected annual average growth rates for the diesel demand are 2.8% for the period from the base year 2004 until 2010, 7.1% for 2010 until 2020 and an average of 7.3% for 2020 until 2025. The sector with the by far highest demand in diesel is the transport sector. The annual average growth rates show an overall increasing tendency with 4.7% from the base year on until 2015 and with 5.8% for 2015-2025. Until 2010, the commercial/institutional sector is expected to contribute with the second highest share to the overall diesel demand in the Gambia.

It should be mentioned, that parts of the future diesel demand are directly related to the future generation / supply of electricity. On the one hand, diesel is an important fuel to produce electricity, on the other hand the amount of diesel which is currently applied for self-generation would be substituted by electricity in total, if it would be available permanently. Due to the expected development of electricity demand / supply, no more significant demand is expected in the commercial/institutional sector from 2011 on, as the electricity demand is fully covered and no additional diesel fired standby-generators are required.

The diesel demand of the Gambian industry is analysed separately for the energy industry and the remaining branches. The diesel demand for the energy industry has to be compared with the Gambian electricity demand as presented in section 8.2.7. The expected average annual demand growth rate from the base year on until 2015 is 11.7%. The projected demand for the second decade is rather minor with an average annual growth of less than 1%.

**Table 19: Diesel Demand Projection in TOE/a (2004-2025)**

| Entire Diesel Demand | | | | | | |
|---|---|---|---|---|---|---|
| | | Base >> | 2010 | 2015 | 2020 | 2025 |
| **Total Annual Demand** | TOE/a | **50,786** | **60,096** | **84,756** | **119,653** | **170,258** |
| GBA - Greater Banjul Area - Annual Demand | TOE/a | 43,137 | 46,896 | 63,270 | 83,815 | 111,741 |
| LGA OF BRIKAMA - Annual Demand | TOE/a | 3,039 | 5,654 | 7,644 | 9,649 | 12,417 |
| LGA OF MANSAKONKO - Annual Demand | TOE/a | 546 | 578 | 729 | 903 | 1,123 |
| LGA OF KEREWAN - Annual Demand | TOE/a | 1,303 | 1,357 | 1,697 | 2,071 | 2,530 |
| LGA OF KUNTAUR - Annual Demand | TOE/a | 583 | 593 | 740 | 938 | 1,186 |
| LGA OF JANJANBUREH - Annual Demand | TOE/a | 803 | 889 | 1,182 | 1,593 | 2,177 |
| LGA OF BASSE - Annual Demand | TOE/a | 1,375 | 1,488 | 1,910 | 2,443 | 3,135 |

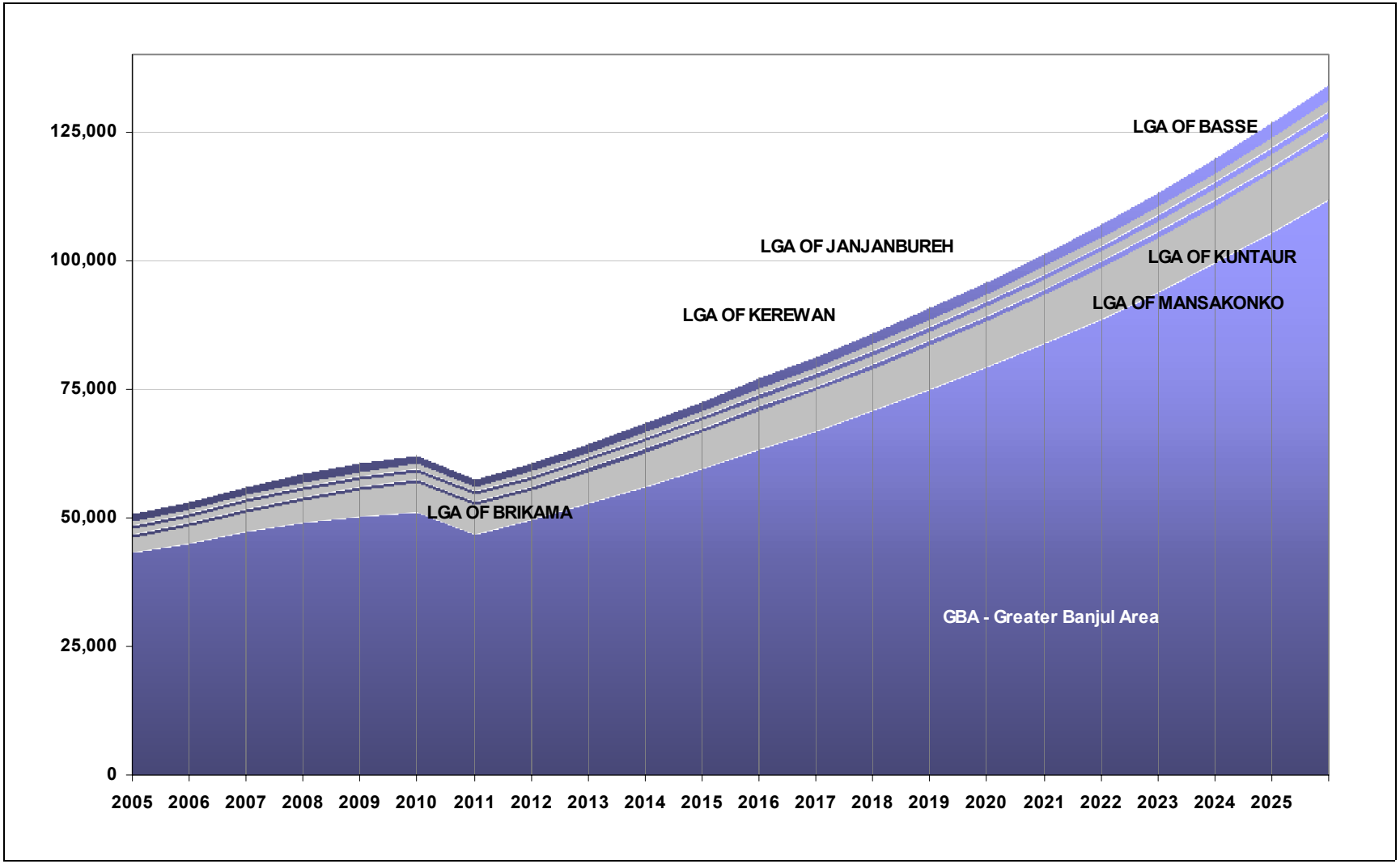



**Figure 48: Projected Diesel Demand in TOE/a (2005-2025)**

For the remaining branches of the Gambian industry, a rather strong increase in diesel demand is projected for the second decade of the forecast period with an average annual growth demand of 14.4%, after a decrease in demand with a determined change rate of -7.2% per year during the first decade. A comparable pattern in demand is expected for the commercial/institutional sector (average annual growth rate base year-2015: -12.7%; 2015-2025: 7.6%), whereas each the agricultural and the residential sector have rather stable annual growth rates with slightly decreasing values (agricultural: 1st decade: 5,6%, 2nd decade 5.4%; residential: 1st decade: 2.7%, 2nd decade: 2.5%).

Annex D.2 displays in detail all further relevant data of the diesel demand forecast.

### 8.2.3 Projected Heavy Fuel Oil Demand

In the Gambia, heavy fuel oil is only utilised in the industrial sector. Its demand is thus only analysed on a nation-wide level and exclusively for the industry, but comparable to the industry sector demand for diesel, distinguished in energy industry and remaining industry. The dominating application of heavy fuel oil is the transformation to the secondary energy source electricity, which is concentrated in the Greater Banjul Area.

Figure 49 displays a relatively steep increase in demand from the base year on until 2009, which is followed by a decrease in 2010-2011. Between the long-term period, beginning in 2011 up to the end of the period under consideration, the demand in heavy fuel oil consumption is expected to increase in a slight and more or less stable manner. Splitting the forecast period in half decades, the following average annual growth rates can be determined for the projected HFO demand: 19.7% from the base year 2004 on until 2010, 2.1% from 2010-2015, 0.1% for 2015-2020 and 0.2% in 2020-2025.

An overview concerning the key figures of the demand of this energy source is provided in Table 20, whereas Annex D.3 provides a detailed break-down for the demand during the period under consideration.

**Table 20: HFO Demand Projection in TOE/a (2004-2025)**

| Entire HFO Demand | | Base >> | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|---|
| **Total Annual Demand** | **TOE/a** | **26,580** | **78,305** | **87,040** | **87,593** | **88,366** |
| Total Electricity Demand at Sent-Out Level (including Suppressed Demand) | TOE/a | 24,861 | 51,257 | 62,278 | 72,881 | 87,453 |
| Electricity Demand to be covered by Primary Energy Transformation | TOE/a | 10,786 | 31,047 | 34,511 | 34,730 | 35,036 |
| HFO Demand of Energy Industry | TOE/a | 26,070 | 76,801 | 85,369 | 85,911 | 86,669 |
| HFO Demand of Other Industry | TOE/a | 510 | 1,503 | 1,671 | 1,682 | 1,697 |

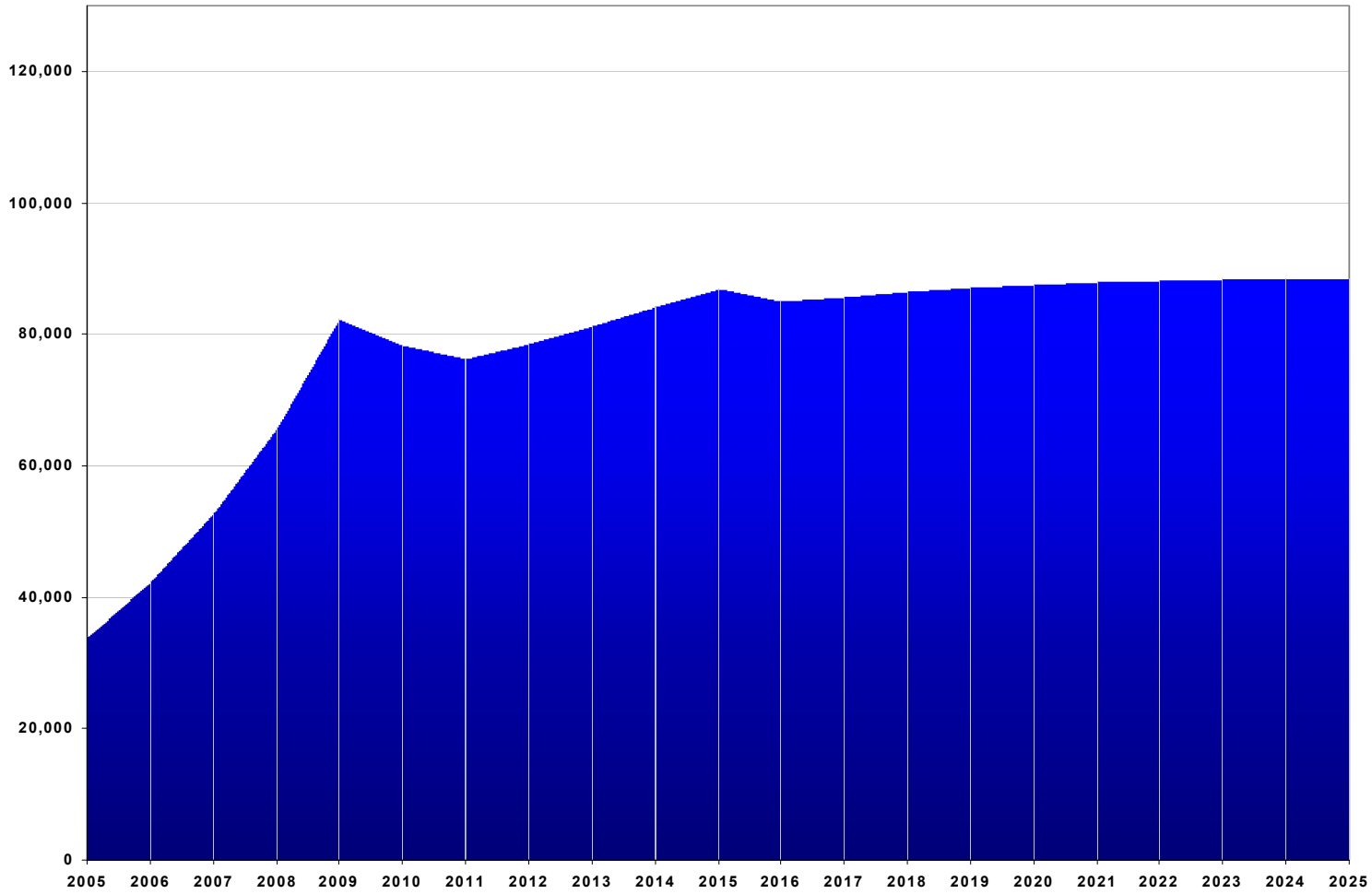



**Figure 49: Projected HFO Demand in TOE/a (2005-2025)**

### 8.2.4 Projected Gasoline Demand

A rather stable increase in demand in the Gambia is projected for the gasoline consumption during the period under consideration. The average annual growth rates, which were determined for the gasoline demand, are 4.9% from the base year until 2010, 4.5% for 2010-2015, 3.4% for the last decade.

This development is also displayed in Figure 50 and Table 21 under reference to the different Gambian LGAs. The major sector in gasoline demand is the transport sector. For this sector, also the highest average annual growth rates are expected. These were determined as 4.8% for the first decade of the forecast period and 3.4%. Beside the development of population number, the assumed development of energy intensity is one of the main determinants with the frame of the gasoline demand projection. Concerning this matter, a decrease of energy intensity to nearly three thirds of its present value is expected until the year 2025. For the other sectors utilising gasoline in the Gambia, comparable growth rates are expected. For the first decade, for all of the remaining sectors, i.e. residential, commercial/institutional and agriculture/fishing, average annual growth rates of 2.9% are expected, whereas for the second decade 0.3% are expected for agriculture/fishing and the residential sector. For the same period, with 0.2% a slightly smaller average annual growth rate is projected for the commercial/institutional sector.

Tables with detailed figures of the projected gasoline demand in the Gambia in 2005-2025 are provided in Annex D.4. The annex provides the absolute annual figures, a break down by sector as well as a break down by region. Concerning the regional break down it is shown, that future demand in gasoline will stay concentrated within the Capital Banjul and its periphery.

**Table 21: Gasoline Demand Projection in TOE/a (2004-2025)**

| Entire Gasoline Demand | | | | | | |
|---|---|---|---|---|---|---|
| | | Base >> | 2010 | 2015 | 2020 | 2025 |
| **Total Annual Demand** | **TOE/a** | **17,651** | **23,557** | **29,418** | **34,719** | **40,978** |
| GBA - GREATER BANJUL AREA | TOE/a | 15,004 | 20,024 | 25,005 | 29,511 | 34,831 |
| LGA OF BRIKAMA | TOE/a | 1,029 | 1,612 | 2,204 | 2,659 | 3,213 |
| LGA OF MANSAKONKO | TOE/a | 191 | 219 | 246 | 279 | 314 |
| LGA OF KEREWAN | TOE/a | 456 | 523 | 585 | 648 | 714 |
| LGA OF KUNTAUR | TOE/a | 207 | 245 | 281 | 318 | 359 |
| LGA OF JANJANBUREH | TOE/a | 283 | 355 | 429 | 525 | 645 |
| LGA OF BASSE | TOE/a | 482 | 579 | 668 | 778 | 902 |

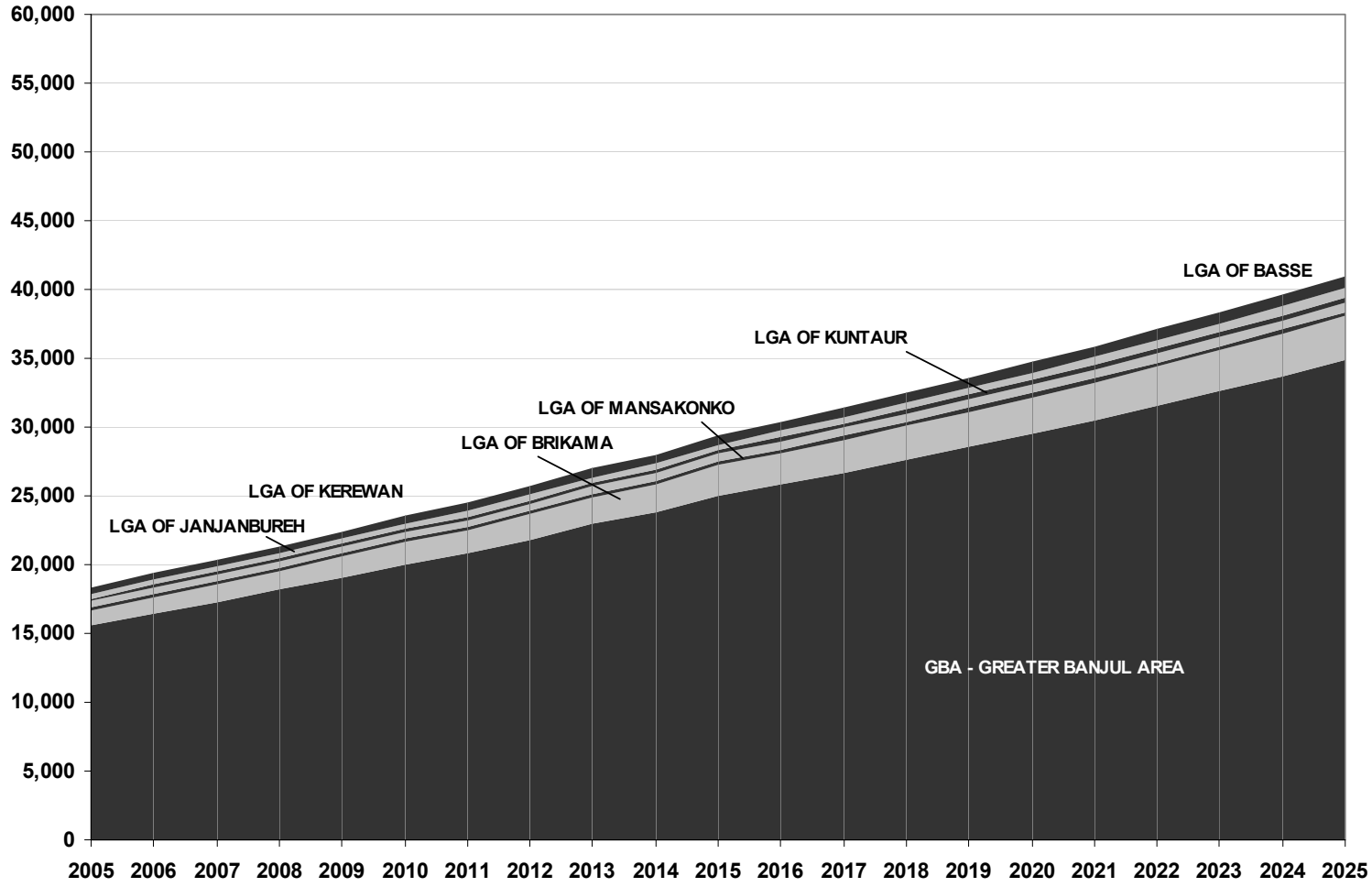



**Figure 50: Projected Gasoline Demand in TOE/a (2005-2025)**

### 8.2.5 Projected Kerosene/Jet Demand

Also for the Gambian kerosene and jet demand, an increasing demand development is projected for the years 2005-2025. This can be derived from Table 21. The average annual growth rates constitute 3.1% from the base year until 2010, 3.3% from 2010-2015, approximately 3.1% for the period 2015-2025.

Jet is utilised in the Gambian transport/aviation sector. Kerosene is used in a higher proportion in the residential sector. Within the residential sector, major consumers of kerosene are the inhabitants of rural areas, whereas a shift in proportion is expected during the forecast period. The overbalance of kerosene requirements in rural areas is thus expected to decline, but inhabitants of these regions are still utilising more of this energy source than those in urban areas. Projected annual average growth rates in the residential sector are 2.1% for the first decade of the forecast period 2005-2025 and 1.2% for the second decade. With 4.7% from the base year until 2015 and 5.0% for 2015-2025, a slightly higher average annual growth rate is expected for the Gambia's transport/aviation sector. Due to the different purposes of Kerosene and Jet, the following Figure 51 and Figure 52 present both, the entire demand projection, as well as the separate household based demand of Kerosene only.

More detailed figures demonstrating the development of the Gambian kerosene and jet demand forecast are compiled in Annex D.5. The annex provides indications for the overall, sectoral and regional demand development over the following twenty years.

**Table 22: Kerosene and Jet Demand Projection in TOE/a (2004-2025)**

| Entire LPG Demand | | | | | | |
|---|---|---|---|---|---|---|
| | | Base >> | 2010 | 2015 | 2020 | 2025 |
| **Total Annual Demand** | TOE/a | **15,350** | **18,393** | **21,605** | **24,929** | **29,119** |
| GBA - GREATER BANJUL AREA | TOE/a | 6,090 | 7,883 | 10,009 | 12,698 | 16,122 |
| LGA OF BRIKAMA | TOE/a | 3,181 | 3,833 | 4,466 | 4,738 | 5,105 |
| LGA OF MANSAKONKO | TOE/a | 430 | 458 | 478 | 497 | 518 |
| LGA OF KEREWAN | TOE/a | 2,351 | 2,539 | 2,677 | 2,744 | 2,813 |
| LGA OF KUNTAUR | TOE/a | 893 | 995 | 1,071 | 1,124 | 1,180 |
| LGA OF JANJANBUREH | TOE/a | 906 | 1,023 | 1,122 | 1,224 | 1,348 |
| LGA OF BASSE | TOE/a | 1,498 | 1,661 | 1,783 | 1,903 | 2,034 |

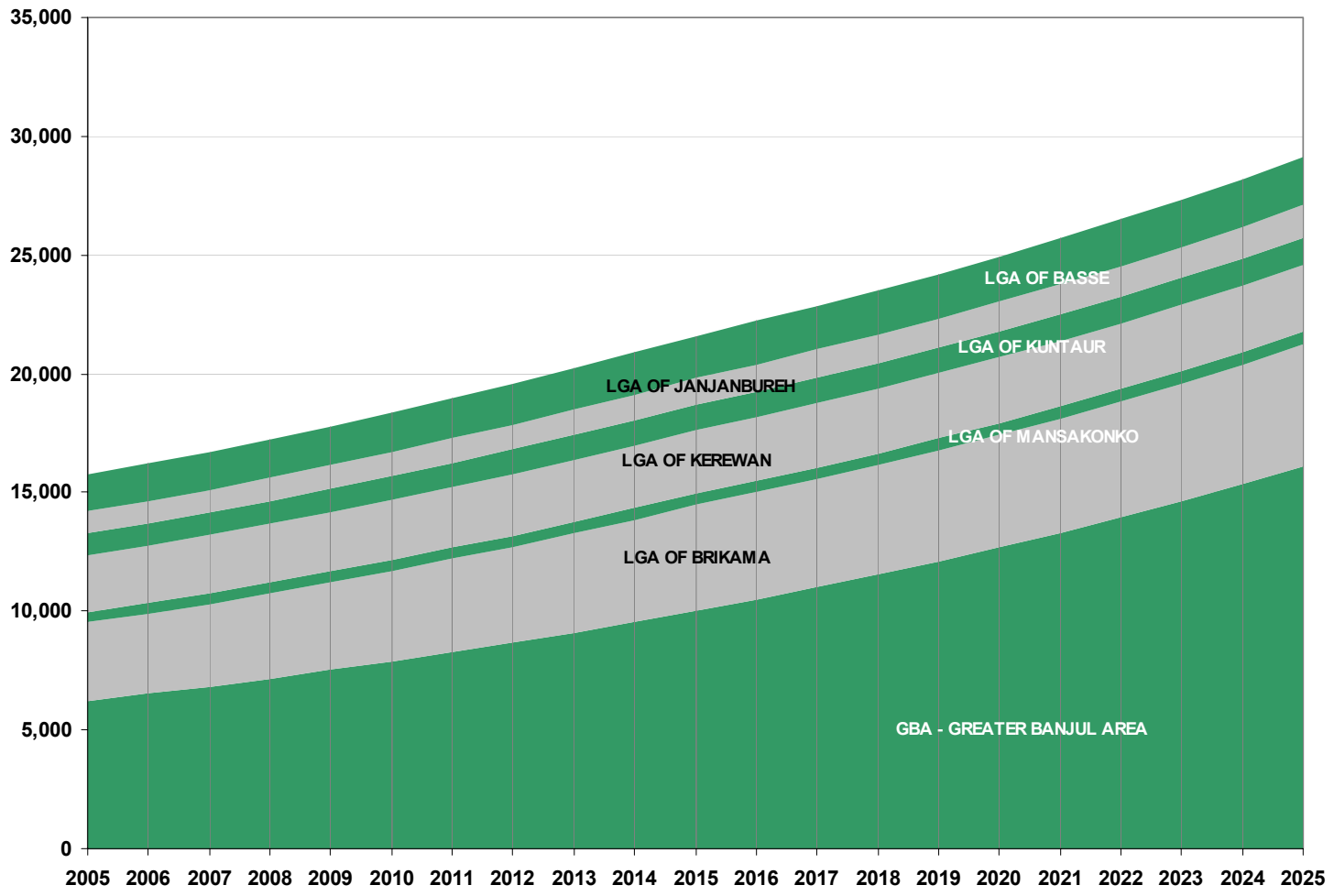



**Figure 51: Projected Kerosene and Jet Demand in TOE/a (2005-2025)**

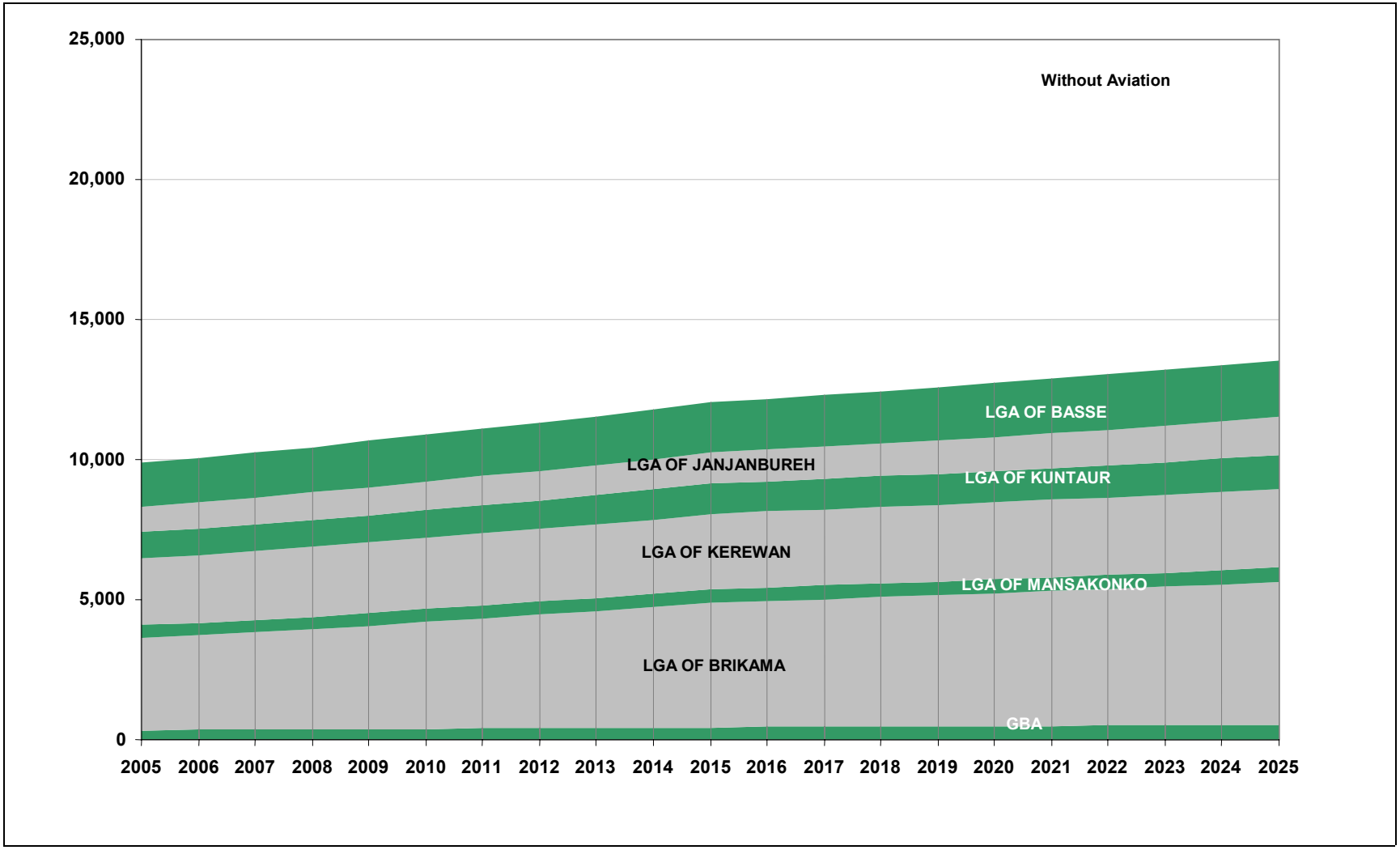



**Figure 52: Projected Demand of Kerosene only in TOE/a (2005-2025)**

### 8.2.6 Projected Liquefied Petroleum Gas Demand

Liquefied petroleum gas is an energy source, which is used in the Gambia's residential sector and the transport/aviation sector. Figure 53 demonstrates the expected increase in demand of LPG during the forecasted period. A division per region is included. This development is also reflected in selected time-slices in Table 23.

Comparable to the utilisation of kerosene and jet, there is also a difference in the consumption behaviour of LPG between urban and rural residents. However, unlike the kerosene and jet demand, the major consumers of LPG on residential level are and remain the inhabitants of urban regions. For the overall residential sector, an average annual growth rate of 4.1% are projected for the period between the base year and 2015, which is expected to be lower between 2015 and 2025. A reduction by an average of 1.8% points is expected over the second decade within the period under projection.

For the first decade, an annual average rate of increase of the entire demand by some 4.2% is expected. Between 2015 and 2025, the forecast results in a slightly higher rate with an average of 4.6% per year. Annex D.6 displays in detail the data of the LPG demand forecast in the Gambia for 2005-2025. It includes the absolute figures, a sectoral and a regional break down.

**Table 23: LPG Demand Projection in TOE/a (2004-2025)**

| Entire LPG Demand | | | | | | |
|---|---|---|---|---|---|---|
| | | Base >> | 2010 | 2015 | 2020 | 2025 |
| **Total Annual Demand** | TOE/a | **15,350** | **18,393** | **21,605** | **24,929** | **29,119** |
| GBA - GREATER BANJUL AREA | TOE/a | 6,090 | 7,883 | 10,009 | 12,698 | 16,122 |
| LGA OF BRIKAMA | TOE/a | 3,181 | 3,833 | 4,466 | 4,738 | 5,105 |
| LGA OF MANSAKONKO | TOE/a | 430 | 458 | 478 | 497 | 518 |
| LGA OF KEREWAN | TOE/a | 2,351 | 2,539 | 2,677 | 2,744 | 2,813 |
| LGA OF KUNTAUR | TOE/a | 893 | 995 | 1,071 | 1,124 | 1,180 |
| LGA OF JANJANBUREH | TOE/a | 906 | 1,023 | 1,122 | 1,224 | 1,348 |
| LGA OF BASSE | TOE/a | 1,498 | 1,661 | 1,783 | 1,903 | 2,034 |

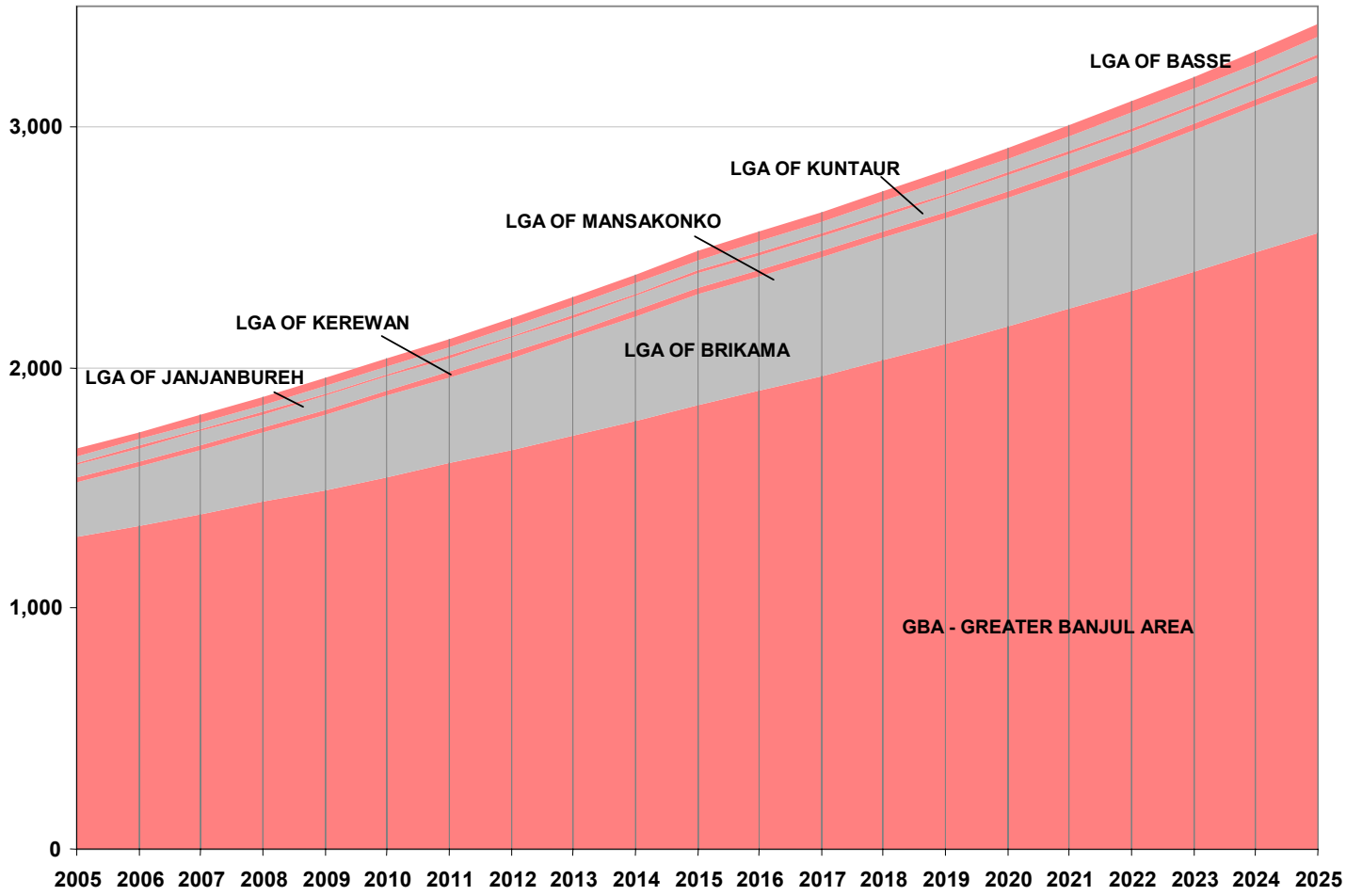



**Figure 53: Projected LPG Demand (2005-2025)**

### 8.2.7 Projected Electricity Demand

As already described in several previous sections, the forecast of the Gambia's electricity demand has a particular significance. Unlike the projected demand of the primary energy sources, the forecast of electricity includes also the projection of electricity requirements including the present and expected future suppressed demand. Figure 54 illustrates the gap between the currently covered electricity demand and the estimated actual requirement, which includes the suppressed demand. Furthermore, it is shown that only due to additional power supply (imports plus increasing domestic generation) this gap can be closed until 2010. The results of the forecast presented are comparable to these, published in NAWEC's own projections. The average annual growth rate for both the electricity demand at sent out level (including suppressed demand figures) is 12.8% from the base year 2004 on until 2010, 4.0% for the period 2010-2015, and approximately 3.6% in 2016-2025. Based on the assumption that the schedule for the several major electricity generation / supply projects can be followed, the annual average growth rate for the estimated demand, which can be served is thus 29.7% for the period between the base year and 2010. For the rest of the considered forecast period the rate of increase is naturally as high as for the entire electricity demand (2010-2015: 4.0%, 2016-2025: 3.6%).

A first overview of the electricity demand development in figures is provided in Table 24, whereas a detailed break-down is given in Annex D.7 of this report. The annex represents figures in detail for each individual customer group, as well as for the several regions of the Gambia. Concerning the latter matter Figure 55 illustrates the expected development of electricity demand for each region of the country. It is displayed, that the GBA will keep the largest proportion, but also illustrated is the increasing significance of the other provinces, which play only a minor role in the base year 2004.

**Table 24: Electricity Demand Projection in TOE/a (2004-2025)**

| Entire Electricity Demand | | Base | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|---|---|
| **Total Annual Demand at Sent-Out Level (including Suppressed Demand)** | MWh/a | **289,079** | **596,016** | **724,164** | **847,450** | **1,016,900** |
| Total Final Demand (including Suppressed Demand) | MWh/a | 216,665 | 496,918 | 638,596 | 762,705 | 915,210 |
| Total Losses | MWh/a | 72,414 | 99,098 | 85,567 | 84,745 | 101,690 |
| **Total Annual Demand at Sent-Out Level (including Suppressed Demand)** | TOE/a | **24,861** | **51,257** | **62,278** | **72,881** | **87,453** |
| Total Final Demand (including Suppressed Demand) | TOE/a | 18,633 | 42,735 | 54,919 | 65,593 | 78,708 |
| Total Losses | TOE/a | 6,228 | 8,522 | 7,359 | 7,288 | 8,745 |

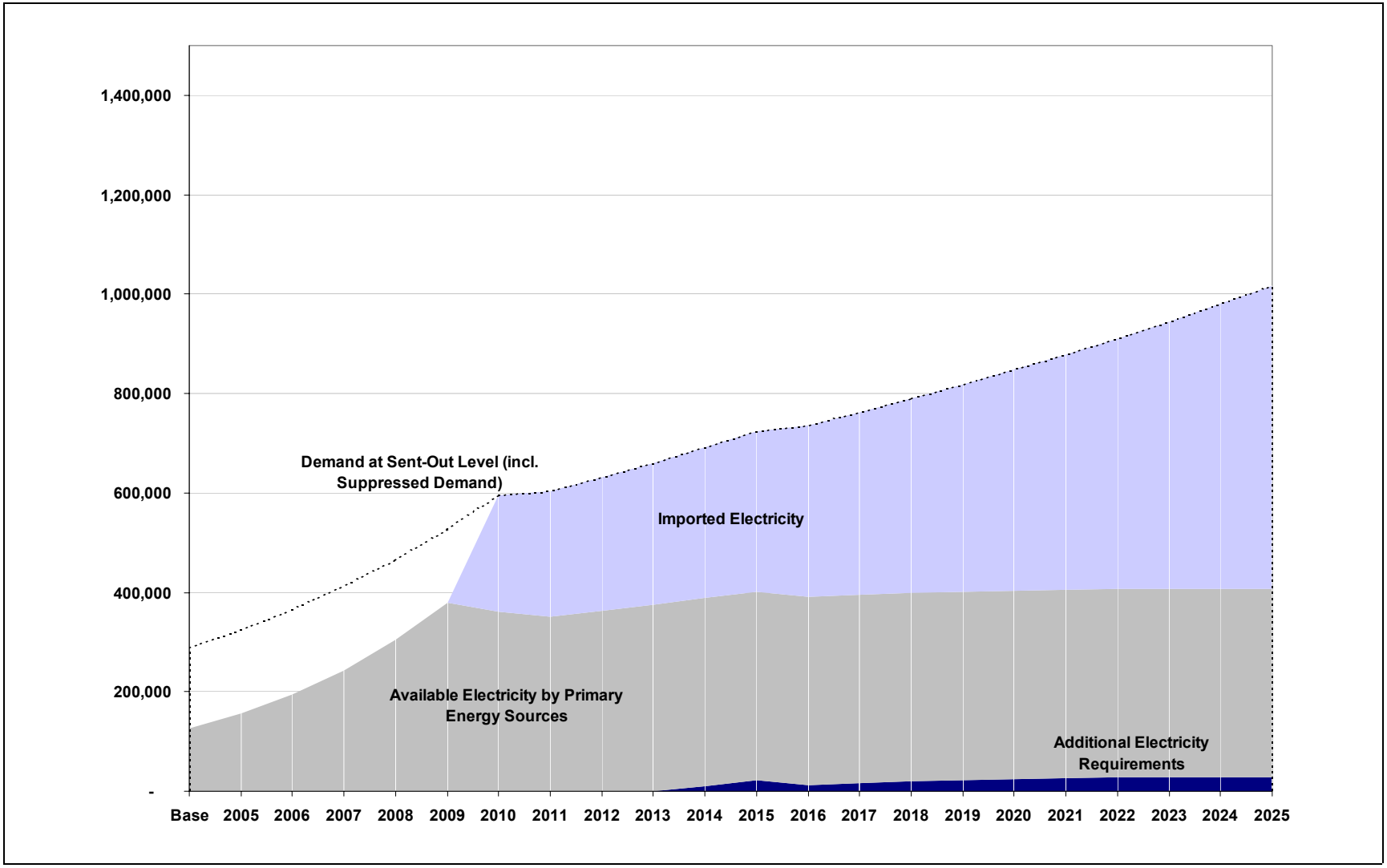



**Figure 54: Projected Electricity Demand in MWh/a (2005-2025)**

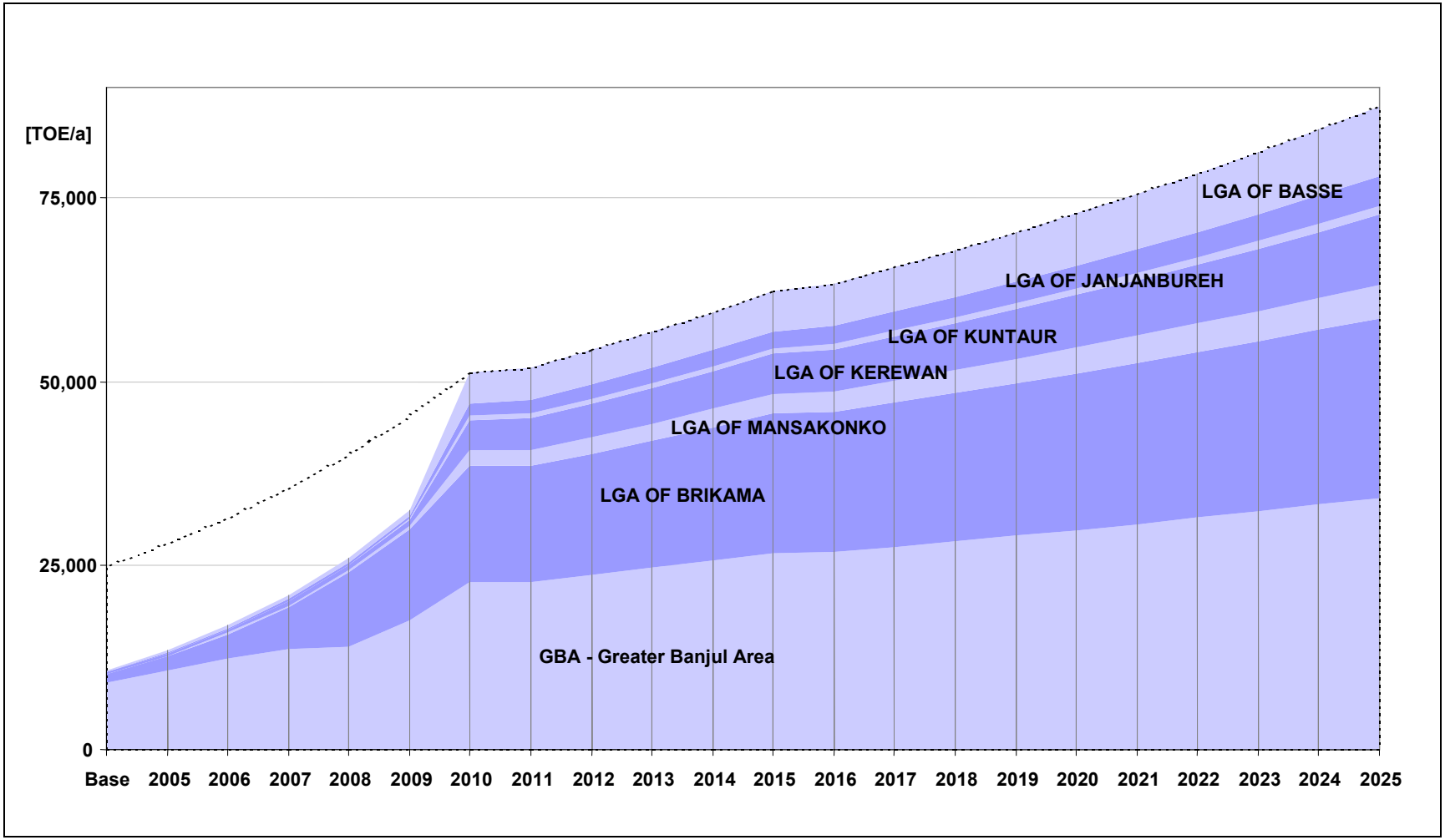



**Figure 55: Projected Electricity Demand by Region in TOE/a (2005-2025)**

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