

# Energy security and Efficiency in Africa

## The case of Senegal

### Selected country and the main reasons for its selection

#### 1. Why Senegal has been selected:

As illustration of the energy security and efficiency study in Africa we made the decision to analyse Senegal's energy system, for three reasons:

First, the system is characterized by a confirmed vulnerability due largely to its high dependence on biomass products and oil product imports. Their shares in the structure of the 2005 assessment are respectively 35% and 53%. Thus, this almost dual structure of the energy assessment marked by the predominance of biomass and oil products may incur risks of a non sustainable and expensive provision of energy in the country and may cause two types of insecurity.

The **economic and financial insecurity** has resulted from the impact of the explosion in oil prices on the market, and consequently from the heavy weight of oil expenses in the balance of payment. For instance, during 2004, with the explosion of the barrel price, imports of those products were estimated at 20% of the overall imported products and they have absorbed almost 40% of the country export returns; it means that the explosion in oil prices involves an immediate recession of the national economy due to the lack of supportive measures.

The **environmental insecurity** has resulted from irrational exploitation of forest resources. It is estimated that 77667 ha of forest have disappeared due to an overexploitation for energy need (SIE, 2006).

The second reason of this selection is justified by the fact that Senegal has undertaken some arrangements in the energy sector with a concern for a secured and sustainable access of its population to energy products, as an incentive. Such arrangements, carried out in all energy sub-sectors are worth to be analysed in order to evaluate their relevancy in this quest for energy security.

The oil sub-sector liberalisation From now onwards the downstream part of the niche, i.e. importing, refining and distributing is open to other actors; it is favoured by the new legal and regulatory framework established.

In the electricity sub-sector, we can note reforms to eliminate inefficiency factors and to bring solutions to financial difficulties, with a modification of rules and regulations in order to open this sub-sector to private operators. In addition, it is worth looking into the contribution of the new comers (CRSE and ASER) in terms of efficiency in the electric energy sub-sector.

The domestic fuels sub-sector. The adoption in 1996 of a new law on decentralisation that strengthened responsibilities of local communities in the management of natural resources and thus the rationalisation of the use of biomass products. From now onwards, a standard of coal to be exploited has been set, and is open to only two areas. Alternative energy policies, butanisation among other things, and programmes for promoting stoves, have been initiated.

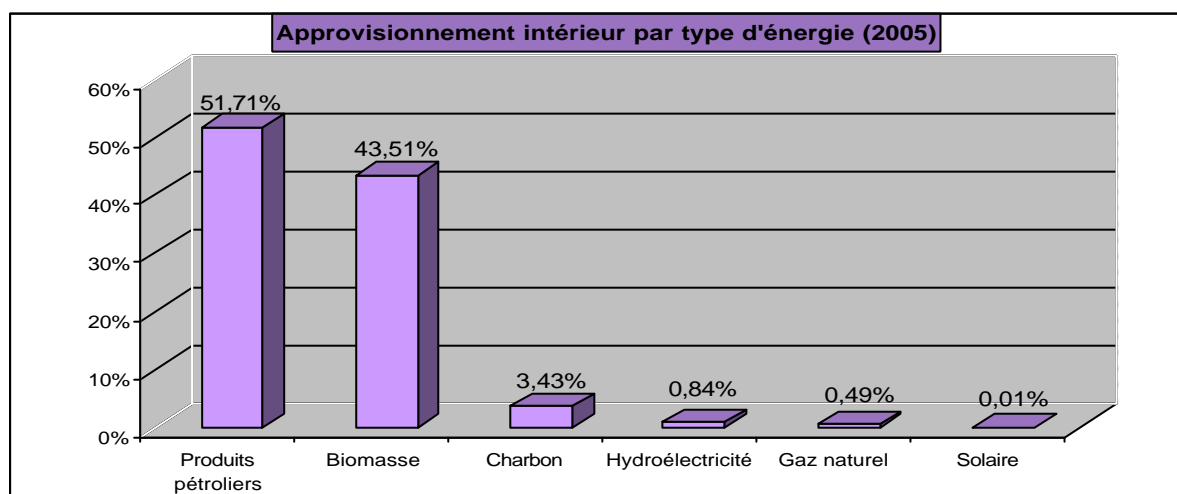
At the same time large energy efficiency programmes have been carried out in the building trade sector as well as audits in a number of industry branches in order to control energy consumption.

Finally, the selection of Senegal is due to operational reasons, particularly, the availability of data. Indeed most of the West African states are suffering from the narrowness of their statistic bases and the discontinuity of series over a period long enough for the rare existing data. However, the establishment of an energy information system (EIS) in Senegal that will facilitate data collection and processing enables to jump over this handicap. By making available a battery of reliable data to experts, EIS helps to obtain elements for the evaluation of various measures taken in the field of energy efficiency and security.

## 2. Overview of energy supply and demand situation in the country and nature of energy security

### 2.1 Primary energy supply

Energy system is composed of three large groups on which the energy policy is centred: biomass, oil products and renewable energy.



Source: Senegal EIS 2006

1- Biomass covers 43.5% of the country primary energy supply in 2005 representing 2819 kt of wood.

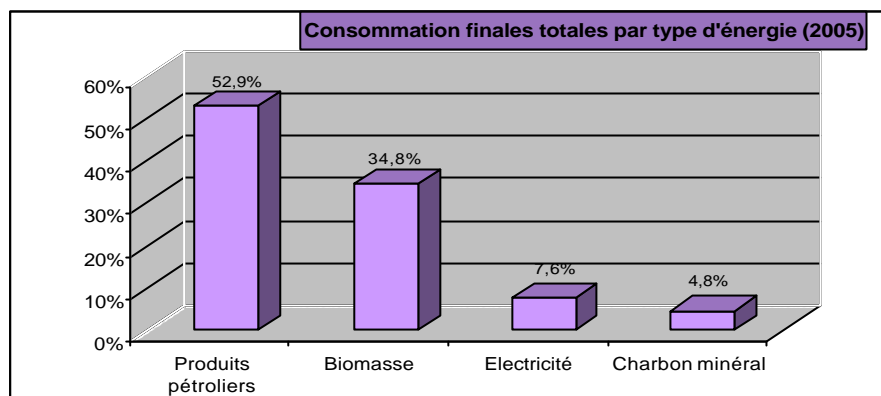
2- Hydrocarbon supply is paid with foreign currency. **Senegal's oil bill has moved from 185 billions F CFA in 2000 to 327 billions F CFA in 2005, accentuating** thereby the social and economic vulnerability of the country.

3- The electricity production is 90% thermal. Only 10% representing 267 GWh of **hydroelectricity production** was generated by the Manantali dam, in 2005. The total installed power of the Manantali power plant is 200 MW (5X40 MW). Its total production is distributed between Senegal (33%), Mali and Mauritania.

## 2.2 Energy consumption profile

### Distribution of the consumption according to the source of energy

The final energy consumption in Senegal was 1972 Ktep in 2005, representing 0,19 Tep per capita. It is dominated by hydrocarbons and biomass as indicated in the following graph.

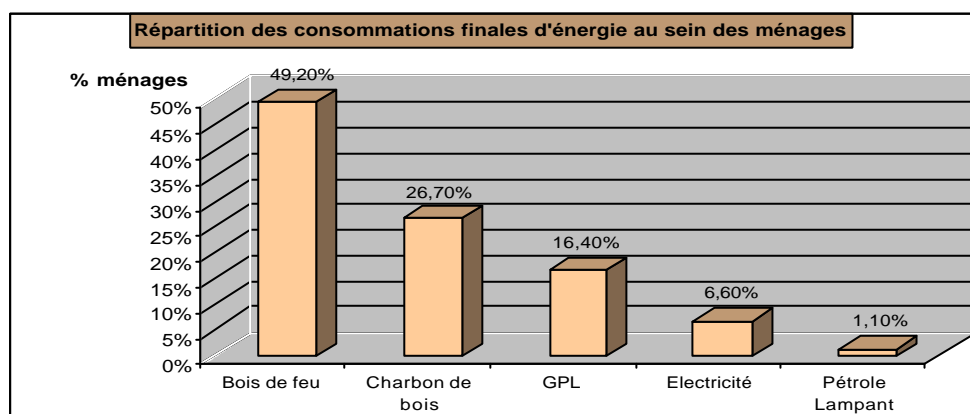


Source: Senegal EIS, 2006

### Households' energy consumption

The source of energy which is the most used by households is biomass which represents almost 75.9% of final consumption. In most cases it is used for cooking.

LPG (used mainly for cooking) represents equally a large proportion of this consumption with 16.4% of the total consumed energy.



Source: Senegal EIS, 2006

## 3- Nature of energy security problem in the country

**Ligneous fuel** is composed of wood and charcoal, which are used essentially for cooking. Supplying households with wood and its by-products is possible from a number of forest stands of two regions: **Kolda and Tambacounda**. The exploitation of forests for biomass energy is governed by a regulation that fixes annually exploitation quotas.

### **Nature of the problems**

- small surface areas (two regions) for supplying the country with biomass energy;
- the non generalisation of forest management;
- lack of energy crops development;
- lack of the forest regeneration capacity control due to smuggling;
- low diversification of domestic fuels;
- lack of standards for stoves using biomass;
- non generalisation of rational use of the biomass due to low monetization of ligneous fuels in rural areas.

**Hydrocarbons** : oil products (petrol, diesel, LPG, etc.) are imported and subjected to a regular price revision from the Hydrocarbon National committee (HNC) in order to consider the fluctuation in the global market prices.

### **Nature of the problems**

- Permanent threat of break in LPG supply due to the poor storing infrastructures;
- Continuous increase in oil products prices;
- Financial problems of SAR (the refining company) for paying shipment coming from abroad;
- Limited number of oil product importers;
- Delay in gas interconnections and in energy cooperation;
- The energy sector is very capitalistic with regard to the very limited public finances;

The electricity production is essentially thermal (90%) and depends largely on SENELEC. Any insecurity in the oil product supplies will hinder the provision of electricity.

### **Nature of the problems**

- ? low access of population to electricity namely in peri-urban and rural areas;
- ? costs for acceding to electricity are very high with regard to the income of the poor
- ? low involvement of private electricity operators has led to a limited diversification of electric energy suppliers;
- ? delays in investments in production equipments have not allowed coping with the increasing demand in electric energy (3.5%/year);
- ? overuse of existing generators to the detriment of maintenance programmes;
- ? low efficiency of production and transport equipment due to their old age. Their age varies between 23 and 39 years;
- ? the global energy performance of thermal power plants belonging to SENELEC is 30%. SENELEC losses are about 446 GWh, representing 21.2% of its energy network;
- ? aborted attempts to privatize SENELEC
- ? lack of social policy

**In short**, Senegal energy sector is subjected to three major constraints which affect the country energy security:

- Irrational exploitation of forest resources due to inefficient modes of biomass production and consumption. The efficiency of carbonisation technologies and biomass final use is very low (20-30%). The transition towards the use of LPG by households is subsidized in a non optimal way, as it does not profit to poor households for whom they are intended. Since 2006, the country is constantly subject to LPG shortages due to several reasons: difficulty in the public

finances, low storage capacity of SAR (in charge of importing LPG and selling it to authorized retailers), fraudulent export of LPG towards riparian countries, etc.

- Predominance of thermal electricity (90%) with a production of 2544 GWh in 2005, of which the fluctuation in the price of oil products increases the cost of electric energy services and impacts on the quality of the electric service provision. SENELEC which is the main electricity supplier is subject to poor performances caused by delays in investment for renewing equipment or increasing the production capacity in order to meet the increasing demand (3.5%/year). Attempts to privatize the electricity sub-sector were unsuccessful. But the additional production coming from hydroelectricity (10%) is subjected to the variability or climate change.

- Renewable energy and energy efficiency are not benefiting from performing policies despite their potential and proven experiences. Solar production (3.6 GWh) represents less than 1% of the potential.

#### 4. Overview of the household sector

##### 4.1 Demographic aspects

In 2005 the total population was estimated at 10 168 262 inhabitants of whom 4.4 millions were living in urban areas representing 41% of the total population, spread out around 67 communes and 6.25 millions inhabitants are living in rural areas representing 59% of the total population, scattered around 13212 villages.

**Table 1: Distribution of the rural population according to the size of the village- 2005**

Locality	Pop <500	500 < Pop.<1000	1000 Pop.<2500	2500<Pop.<5000	Pop.>5000	Total
Population	2,026,378	1,192,924	1,710,088	600,230	716,860	6,246,481
Nber of households	202,638	119,292	171,009	60,023	71,686	624,648
% Total Pop.	32.44%	19.10%	27.38%	9.61%	11.48%	
Nber of villages	9963	1791	1222	180	56	13212
% Villages	75.41%	13.56%	9.25%	1.36%	0.42%	100.00%

It decreased from 67.9% in 1994/95 to 57.1% in 2001/2002, representing a reduction of 10.8% in absolute term and 16% in relative term.

**Table 2: Poverty and disparities in Senegal 1994-2202**

	Households				Individuals			
	National level	Dakar	Other urban areas	Rural areas	National level	Dakar	Other urban areas	Rural areas
	1994-95							
Impact of poverty (%)	61.4	49.7	62.6	65.9	67.9	56.4	70.7	71.0
Acuity of poverty (%)	20.5	15.4	21.4	22.3	23.6	17.7	24.4	25.3
Seriousness of poverty (%)	9.1	6.4	9.5	10.0	10.6	7.4	10.8	11.7
Gini Coefficient	38.6	45.8	39.7	31.7	32.6	36.7	34.0	29.4
	2001-02							
Impact of poverty (%)	48.5	33.3	43.3	57.5	57.1	42.0	50.1	65.2
Acuity of poverty (%)	14.8	9.5	13.4	17.8	18.3	12.0	16.1	21.4
Seriousness of poverty (%)	6.2	3.7	5.7	7.5	7.9	4.7	6.9	9.4
Gini Coefficient	37.4	41.9	38.3	29.9	34.2	37.3	35.2	30.1

Source: ESAM II, 2001/2002, ESAM I 1994/1995

Poverty impact mitigation is more visible in urban areas than in rural areas. In rural areas 65.2% of individuals and 57.5% of households are living under the poverty line. These percentages are lower in other cities (respectively 50.1% and 43.3%) and lower in Dakar (42.0% and 33.6%). Rural areas contribute to poverty for 65% and on the other respects; Dakar which harbours a quarter of the population contributes for less than 18% (DRSPH, 2006).

## 5. Energy scenario at the household level

In the absence of specific scenarios we refer to energy policy objectives derived from recommendations of the white book of ECOWAS which is the reference of countries.

- 100% of the population living in rural and peri-urban areas will have access to a modern energy system for cooking, by 2015.
- At least 60% of people living in rural areas will reside in zones where access to services will be easier in order to increase the productivity of economic activities,
- 66% of households have access to electric services of which at least 30% are living in rural areas.

## 6. Indicators for energy security

Energy as an essential factor of socio-economic development may be considered as a strategic good, which supply security is relating to the national sovereignty. In the context of the South countries such as Senegal, energy sovereignty is rather illusive, in the sense that objectives as defined in the LPDSE do not put emphasis on this dimension. In other respects, prospective studies do not identify scenarios in this perspective.

Within the framework of the process of identifying access indicators and impacts with regard to energy security, it seems necessary to address the question from the angle of *supply* (national production and import) and *consumption* in their functional relation, because it addresses energy security in the perspective of *energy sovereignty*. This notion refers to stability factors of the energy system and even to its capacity to meet the demand for cheap

energy services, in a sustainable and efficient way with regard to ecological, economic, social and geopolitical threats.

## **SUPPLY**

Talking about security in energy supply, is to touch on the notions of physical, economic, environmental and technological security. It is seen from the supply side. The following indicators would be relevant in a dynamic analysis:

- Oil products storage capacity
- Investment in Energy/national budget
- Oil product suppliers
- Evolution of wood fuel production quotas
- Level of investment in renewable energy

## **CONSUMPTION**

Energy services consumption refers to access issue. It represents the demand side. The evolution of access indicators (economic aspects and quality; access rate) can be analysed as follows:

- o Households equipment rate
- o Access rate (electricity, LPG, improved biomass)
- o Level of energy consumption/household
- o Gender (budget-time sequence, activities contributing to GDP/households, social roles of women in activity; access to a modern form of energy; access to an improved stove;
- o Rate of energy service failures (power cut)
- o Energy transition rate
- o Energy expense ratios (household expenses, household incomes)
- o Energy efficiency factors

Impact indicators of energy security can be defined as follows:

- o Social impacts
- o Economic impacts
- o Environmental impacts
- o Sustainability of energy system

In short, we can consider that the main function of energy supply is to ensure a quality and sustainable consumption for households and other economic actors. It is in this respect that energy security contributes to economic and social development of the country.

## **7. Main issues to be studied into details for the first report draft**

- Senegal's energy supply problems (domestic fuels, electricity and oil products)
- Factors of the energy system instability in its various components (elements of performance)
- Impacts of energy supply on the national economy (macro) and on households (micro analysis)
- Appropriate measures for enhancing energy security

- Path to follow for next steps

## **8- Methodology**

The global objective of the study is to analyse energy insecurity in Senegal and its consequences on the economic growth pro poor, to collect solutions proposed by different actors for mitigating impacts on households.

The methodology proceeds step by step

**Step 1:** Collecting the primary data in the energy sector in order to analyse the weaknesses of the energy system with regard to resources, the politico-institutional framework as well as the sector planning.

Then, on the basis of selected indicators, we will analyse impacts of the energy insecurity on macroeconomics in order to give information on the influence of the energy service evolution on the GDP. In addition, the economic and financial vulnerability of households will be studied with regard to the energy instability. Households will be analysed on the basis of recurrent energy services by focusing on three pillars: domestic fuels, motive force and electrification. The results of the enquiry on peri-urban areas can be useful and if needed, strengthened by some focus groups and small enquiries centred on women head of household to address the **gender issue**.

**Step II:** Analyse recommended policies/measures implemented by different actors in order to control energy insecurity or mitigate its impact on poor households. The analysis will be based on experiences that bring changes on energy production and consumption modes in terms of energy rational use, introduction of new forms of energy, etc.

## **9. Data sources**

ESAM II  
SPRP II  
DEA  
DPEE/MEF statistics  
SAR statistics  
CNH statistics  
EIS