

## Analysis of Gas Sector in Cote d'Ivoire: History, Current Status and Policy

Aboh Prisca Zidago<sup>1</sup>

Zhang Wangqi<sup>2</sup>

China University of Geosciences, Wuhan  
China

### Abstract

*In Cote d'Ivoire, the electricity sector is a major consumer of gas, in order to fueling gas turbines for electric production. Natural gas consumption is increasing throughout Cote d'Ivoire, particularly as a cooking fuel .LPG is distributed through population in cylinders... This paper examines of an analysis about Gas sector in Cote d'Ivoire. Firstly, this analysis is based on the gas production and consumption However, due to the increase in gas marketing in the world that is growing more and more, so we analyzed the gas price. Finally, this paper gives policy suggestions on Cote d'Ivoire's gas industry.*

**Keywords:** Gas production, Gas consumption, Gas price

### Introduction

Considered the fossil fuel of the 21st century just as oil was in the last century and coal two centuries ago (Energy Information Administration: EIA (2000)), natural gas is the second most used energy source after oil. Its share of world energy production was 23% in 1999 (E.I.A) and its application development prospects are excellent. Today, natural gas has 24.7% of global energy consumption with the world's proven reserves of more than 150 Tm<sup>3</sup> (m3 Trillion). According to the Commission Energy-Environment Canada (2002), natural gas is considered the main way after saving energy, reduce greenhouse gas emissions related to energy consumption It is actually very well placed because it can substitute for all other primary energy sources (oil, coal ...), both for the production of electricity for the operation of vehicles, and because it rejects roughly two times less CO<sub>2</sub> than oil or coal per unit of energy consumed. Since the oil crisis of the 70s, governments gradually have introduced natural gas to the agenda of their energy policy. In this context, the provision of energy from natural gas has become one of the priorities of the energy policy of the Ivorian government with the aim of:

- To ensure energy independence of the country and provide the sub-region in electricity, butane gas and natural gas;
- Strengthen the competitiveness of the economy by reducing medium term through the development of gas resources, energy cost (Economic Mission in Abidjan, 2001).

Indeed, having long imported electricity from Ghana, the Ivorian government in terms of its large reserves of natural gas has seen fit to develop the production of electricity from natural gas. In 1990, Côte d'Ivoire launched a development project for electricity from gas turbines. Thus, since 1994, exports of electricity produced by thermal power plants in the direction of Ghana, Togo and Benin. Due to high costs of electricity and electrical appliances, Cote d'Ivoire's rural households are highly dependent on natural woodland and forest resources for fuel and as a source of income. In 1996, households consumed on average approximately 2 kg of charcoal and 4.6 kg of wood fuel per day (Cote d'Ivoire Ministry of Environment and Sustainable Development, 1997). This level of charcoal consumption is equivalent to 0.73 of a ton of charcoal per household per year.

---

Aboh Prisca Zidago, Ph.D., China University of Geosciences research areas/ interests: energy consumption by household, Abohprisca2010@gmail.com

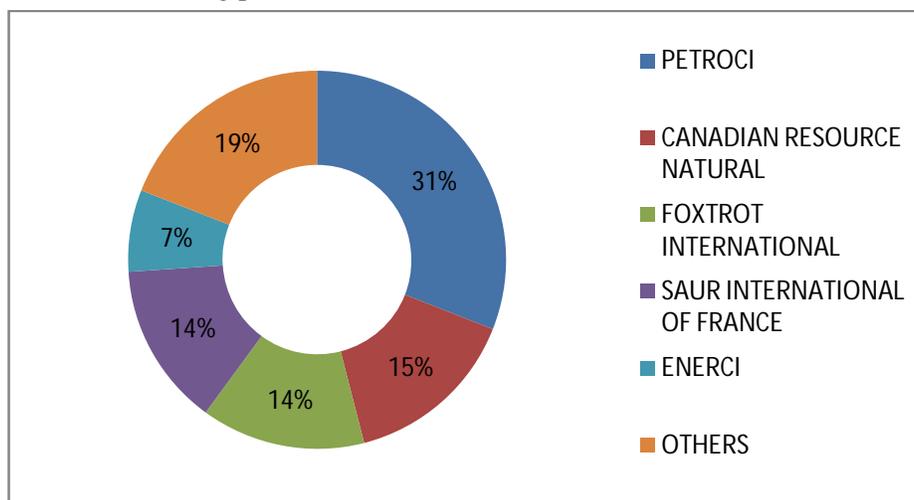
Zhang Wangqi, Dr., Professor, Faculty of Land Resources management, Department of Business administration China University of Geosciences; research areas/interests: Land management. E-mail: qshwu@cug.edu.cn

In order to allow comparison with the FAO's worldwide data, the FAO estimate of 0.7 of a ton of charcoal per household per year will be applied in the following baseline scenario assessment. Ivorian households are therefore exposed to a real problem of indoor pollution, but what are the steps taken by the government to address the environmental problems? What is the Ivorian energy policy? What are its limitations? In 1995, the butanization policy is established by the Ivorian government to fight against deforestation. The government also has promoted the use of improved stoves in rural and urban areas. By contrast there is no energy policy in terms of production and consumption charcoal/woodfuel. This policy has a problem at the affordability of household energy. According to data released by the Ivorian Electricity Company (CIE), the number of households with a subscription to electricity compared to the total number of households in Côte d'Ivoire is equal to 27.5% in 2011.

## 2. Gas Production System in Cote D'ivoire

Almost all of Côte d'Ivoire's gas production is currently utilized for domestic power production, underscoring the increasing tightening market fundamentals which will soon start to see demand for gas-to-power exceed production of available gas reserves in the country. In 2012, Côte d'Ivoire produced an estimated 46 billion cubic feet, which was almost equal to the total amount consumed in the country in the same year. Thus unlike its petroleum product surpluses annually, Côte d'Ivoire has little to no surplus gas that it can export to end-users in the West Africa sub-region. In 2012, the government of Côte d'Ivoire was set to approve development plans for the Manta gas field in the offshore block CI-27 owned by Foxtrot International, an affiliate of French gas giant Bouygues Group. Bouygues intends to spend an estimated \$268 million developing the field, which could see gas production rise by another 155 billion cubic feet from 2016.

In addition, Australia-listed explorer Rialto Energy also intends to commence gas production from the Gazelle field in its block CI-202 in 2013. These developments will significantly boost gas production in Côte d'Ivoire. Any additional gas production would immediately support efforts for gas exports into the West African Power Pool (WAPP) for Côte d'Ivoire's neighbors, Sierra Leone, Liberia, and Guinea. However, it also draws underlines the lack of adequate gas infrastructure to support the distribution of gas to Côte d'Ivoire's own power stations. With its array of promising gas fields, Côte d'Ivoire is also seriously considering a connection to the West African Gas Pipeline (WAGP) ahead of gas production in the Jubilee field in 2013/2014. WAGP currently runs from Nigeria through Benin Republic and Togo to Takoradi in Ghana. Extending the pipeline to Assinie in eastern Côte d'Ivoire, a distance of 300 km will however cost an estimated \$645 million. The Ivory Coast is self-sufficient in producing refined petroleum products and is also a major supplier to the West African region. Six major oil companies are involved in marketing products in Côte d'Ivoire as well as the local PetroIvoire. (See figure 1)



**Figure 1: Côte d'Ivoire's main gas producers**

The Foxtrot offshore gas field was discovered along with the Panthere gas and condensate field in 1993 and the Lion oilfield in 1994, both of which came on stream in the mid 1990's. The product is intended for use in local power generation with excess being sold to Ghana. Addax reworked the aging Espoir oil field in 1996, and a consortium led by Ranger Oil intends to develop the abandoned field at a cost of \$250 million with initial production being estimated at 20,000 to 25,000 bpd.

## 2.1 Gas and Petroleum supply: international view

Cote d'Ivoire is the only country in the West African region that is self-sufficient in the production and consumption of petroleum products. Since 2005, Cote d'Ivoire has consistently exported more refined products than it has imported. Within the West Africa, Cote d'Ivoire is the smallest importer of refined products at 94,000 tons, after Guinea-Bissau, which imported 70,000 tons in 2011. Compared to other refining countries in the region such as Nigeria, Ghana and Senegal who imported 16 million, 1.9 million and 1.3 million tons respectively Cote d'Ivoire ranks as the second smallest net importer of petroleum products in the West Africa sub-region.

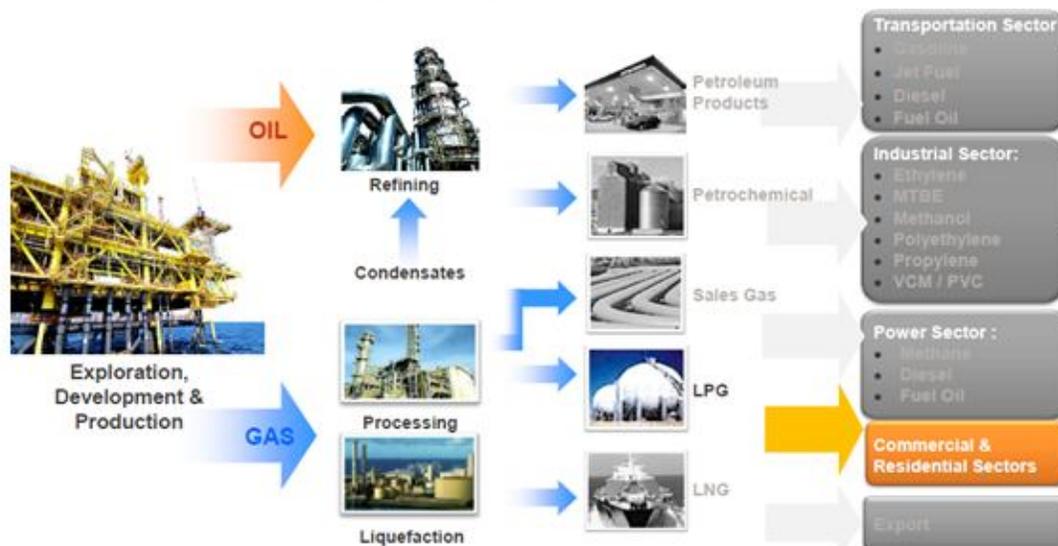


Figure 2: oil and gas supply in Cote d'Ivoire

## 2.2 Exploration and production

Technological developments have played a leading role regarding the prospects of natural gas in the world in general and in the Ivory Coast in particular. The innovations of natural gas industry are held constant at all stages of the process and even for natural gas applications. They economize energy that helps reduce costs, environmental impact and permit gas to reach its end users. Natural gas is extracted by digging a hole in the rock. Drilling can be done on land or at sea. The equipment used is according to gas location and the nature of the rock. If it is a formation shallow drilling, cables can be used. A movement back and forth is performed repeatedly using a metal wick into the ground. For more in-depth prospecting, rotary drilling platforms are required. They are most common today. This method consists of a pointed wick that allows passing through earth and rock. In drilling techniques, innovations have allowed to gather more information on wells, to drill deeper and reduce costs. An underground deeper drilling gives access to reserves of natural gas that could not be reached before.

Once, the natural gas found it to be effectively taken. The most effective recovery rate is given by the maximum amount of natural gas that can be extracted over a period of time without damaging the formation. After his extraction of subsoil, natural gas must be processed by Total/FinaElf, Shell, Petroci Gaz (subsidiary company Petroci Holding), and Gestoci (main actors of hydrocarbons storage in Côte d'Ivoire). The pipeline industry seeks to continuously improve the capacity, safety, efficiency, and profitability of gas pipelines to reduce transportation costs. This phase represent an important part of the final product price. Technological advances in the liquefaction process, aimed at turning natural gas into liquefied natural gas (LNG), promote also expansion of international trade.

## 2.3 Distribution

Research and development in the natural gas delivery field, try to develop for two applications that are the gas fireplace and cooling systems as well as new technologies aimed at reducing costs and improving efficiency. Some technologies can be cited for examples are: flexible distribution piping, plastic distribution pipes, electronic metering mapping informatics systems, or new trenching techniques. Retailers also need to control the flow of gas through informatics systems as the regulation by valve controlled or by SCADA system (control and input monitoring data). The market of butane gas distribution in Ivory Coast represents nearly 60,000 tons for 2000 year, an increase of approximately 11% over 1999 year Butane gas come from the S.I.R.

(Ivorian Refining Company) with two possible origins: local production (including natural gas come from the "Lion GPL" equipment) for a third party and imported gas for the remaining two thirds. The distribution market is divided into two separate entities in terms of conditioning and mode of gas delivery:

**'Conditioning' activity:** in gas cylinders of de 6 Kg , 15 Kg et 32 / 38 Kg, Butane gas is sold to wholesalers, by oil distribution companies, which are responsible for bottling (Gas Petroci, Total FinaElf, Shell, Agip, Mobil). Shell, Agip, Total and Petroci Gaz have filling stations.

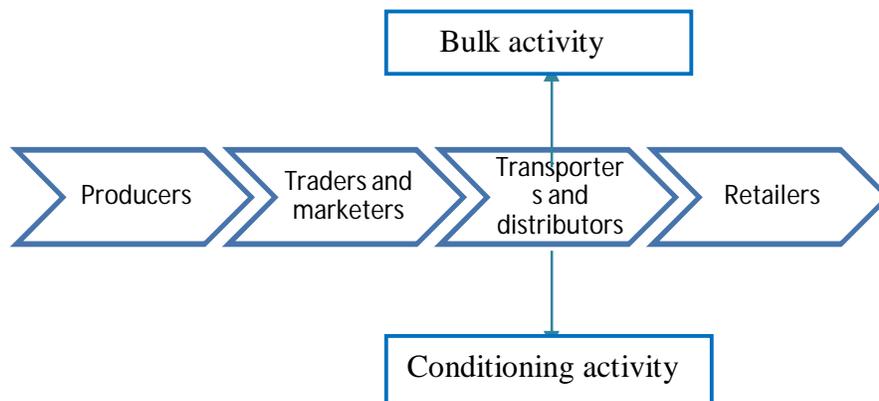
**"Bulk" activity:** delivered by truck, butane gas volume is sold and represents 7000 to 8000 tons per year. Shell and Total share respectively 35 and 65% of the market but since 2011. PetrociGaz has developed his gas distribution in bulk activity.

## 2.4 Supply chain

Gaseous propane and butane take up about 250 times as much space as in the liquid state. To conserve space, LPG is pressurized in metal containers at ambient temperature or else refrigerated to transport and store as a liquid. The need to keep LPG pressurized or refrigerated and associated metal management add considerably to the supply cost of LPG.

Commercial participants in the LPG supply chain include the following factors:

- *Producers* sell LPG at the refinery or natural gas processing plant gate.
- *Traders and marketers* buy LPG in bulk from producers or from overseas markets, store it in large primary terminals, and sell it to other marketers, distributors, retailers, and final consumers.
- *Transporters and distributor's* truck, rail, or pipe bulk LPG to their regional depots where it is stored in large pressure vessels, and then supply LPG to bulk customers by small road tankers. LPG is bottled in cylinders and distributed to retailers.
- *Retailers* sell LPG to small customers, including households. The retail outlets may be retail branches or commission agents of a marketer, or independent resellers who purchase and resell LPG in marketer-owned and branded cylinders. Autogas is sold at filling stations.(see figure 3)



**Figure 3: Supply chain in Cote d'Ivoire (by actor)**

## 2.5 Gas Production

Gas production by 4 major gas production fields in Cote d'Ivoire we have showed that three production fields between 10.000 MMscf/day and 60.000 MMscf/day. Only A3 field has a higher production between 60.000 MMscf/day and 150000 MMscf/day, this field is that of FOXTROT company (see figure 4).The sales gas curve shows same trend as that of the average gas production, because his curve as it evolves. In 2011, the fall of gas production is due to the socio economic crisis in Cote d'Ivoire. Since the fall of gas production, the sale of gas increases gradually end of the year 2012 until 2015.

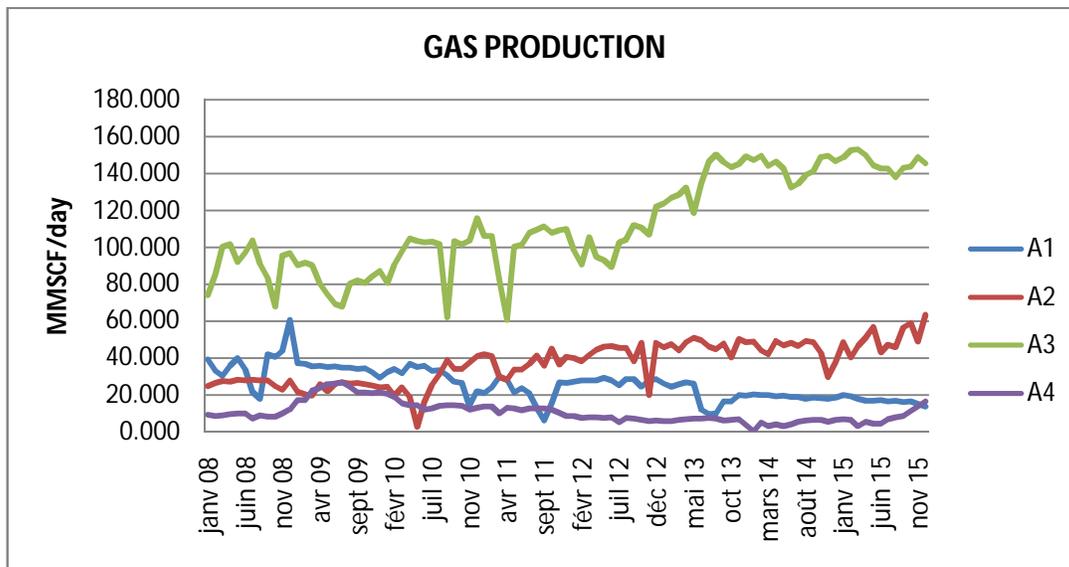


Figure 4: Curve of Gas production by day between 2008 and 2015

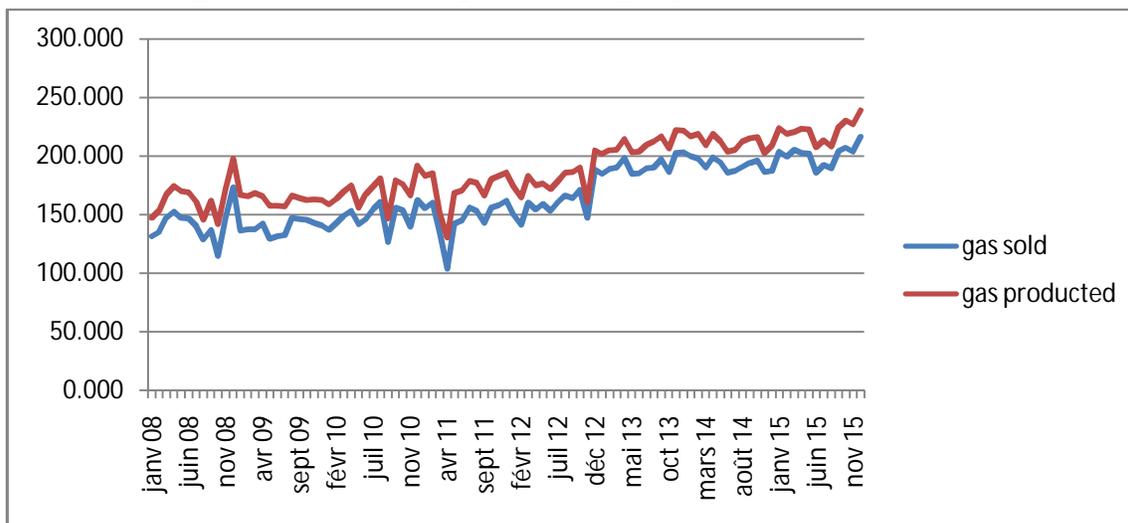


Figure 5: Curve of gas sales compared to the average production

### 2.6 Gas pricing

The most important disposition is formula; this formula links the price of natural gas WTI crude (West Texas Intermediate). When negotiating contracts, natural gas was an alternative fuel whose price was linked to that of heavy crude oil; but in the early 90s, producers attempted to persuade the government to give up this link heavy crude oil. This requires choice of an indicator WTI seemed to be best option because it was more consistent and less variable than alternatives such as Brent (North of sea). it was thought that this approach would have advantage for both parties. If price experienced a significant decline, there would be no guarantees to producer and government would benefit. The price formula is based on a monthly average over the last 12 months.

The underlying idea is that this reduces price volatility during this period and covers long-term changes. the using a US \$ 15 price seemed so reasonable for both parties in the natural gas and electricity sectors (ie producers / sellers and users / buyers).we can also point out that at the time of these negotiations, LNG trade was much smaller than it is today and therefore there was no obvious comparison that could serve as references for negotiators for fix the price of gas in the Cote d'Ivoire. The price of gas varies according to fields and operators, but it is generally bound to the WTI crude prices and is not capped. The monthly price of gas is based on the average price of WTI of previous 12 months. The specific basic formula of gas price is  $WTI * 1.67$  divided by 15 for the first 20 Mcf / day and higher amount is 20 Mcf / day is  $WTI * 1.5$  divided by 15.

## 2.7 Law and regulation on oil and gas activities in Cote d'Ivoire

List the main legislation governing petroleum exploration and production activity in your country. The Ivory Coast hydrocarbon sector is governed by:

- Law No. 96-669 of 29 August 1996 relating to the Petroleum Code (the 'Petroleum Code')
- Decree No. 96-733 of 19 September 1996, implementing the Petroleum Code and
- Decree No. 2012-369 of 18 April 2012 amending Law No. 96-669 of 29 August 1996 relating to the Petroleum Code.

The different Government bodies principally responsible for regulating oil and gas activities are:

- (a) The Minister of Mines, Petroleum, and Energy responsible for the promotion and control of petroleum activities (the 'Ministry')
- (b) The Interdepartmental Petroleum Commission notably in charge of the technical review of the applications for petroleum agreements or research permits/authorizations and
- (c) The Centre of Promotion of Investments ('CEPICI') that advises the Government on questions concerning the implementation of the Petroleum Code.

### Comparison of gas consumption b rural households and urban households

Qualitative and quantitative data were gathered using structure and semi-structured interviews. This study examined factors affecting household use of LPG, the state of LPG markets in developing countries, and measures to enable more households to shift away from solid fuels to LPG. Household LPG use was examined through a survey of household energy data for cooking. Predictably, the share of households using LPG was higher in urban than in rural areas. LPG prices have more increase in the last decade. This rate of increase is much higher than that for household income. These data showed that only 20% of the population use butane gas and 80% others prefer to use other poor energies such as fuel wood or charcoal (see figure below). So, Freund et Wallich related that a price increase has an immediate effect on consumption and household welfare, and the extent of that effect depends on the share of energy in the total household budget (Freund and Wallich, 1997:49). The doubled structural shortage of speculation on the price of butane gas leads populations often use biomass (firewood) as an energy source; what constitutes a threat to environmental protection and the balance of biodiversity.

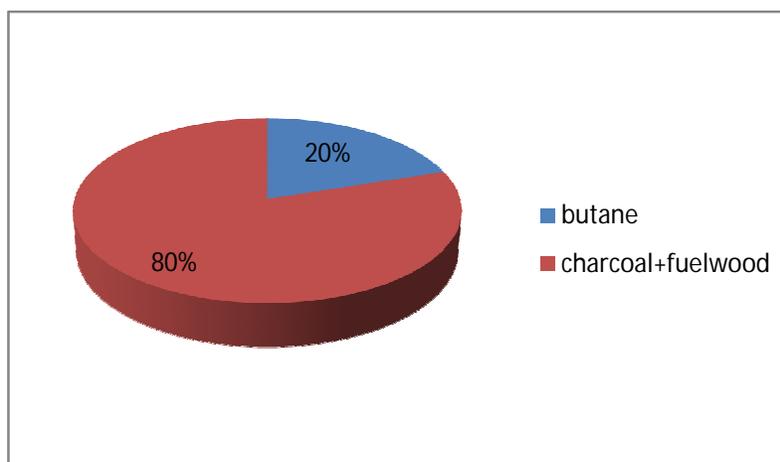


Figure 6: fuel consumption b household for cooking in Cote d'Ivoire

## 3. Discussions and Conclusions

The primary goal of this study is to analyze the production, distribution, and consumption of gas in Cote d'Ivoire. In order to fight against deforestation, Ivorian government has introduced the butanization within Ivorian households. In the Cote d'Ivoire, the search for hydrocarbons has really developed in the early 1970. The presence of petroleum company majors such as Philips Petroleum and Esso has resulted in the exploitation of petroleum fields such as Espoir field and Belier field in 1980. In 1990s, a review of tax system and the adoption of a new law on oil code promulgated in 1996 have greatly contributed to stimulate new foreign oil companies to operate in the Ivorian sedimentary basin.

Despite efforts to promote the use of butane gas and the planned biogas program, most rural households and peri use firewood or charcoal. It is proved by WHO that smoke that comes from the use of wood for cooking causes respiratory diseases and approximately two (2) million women and children die every year due to this practice. The use of improved stoves with chimney is one of the ways indicated for rural areas in Cote d'Ivoire. This simple technology uses less wood and thus to preserve nature and save lives. The state will also implement short-term pilot projects of biogas production in rural families, in the rural health centers and schools. In the long term, develop outreach programs for the use of biogas in rural areas. The realization of all these actions requires the cooperation with countries with long experience of biogas, especially China and India.

### References

- Commission Energy-Environment Canada (2002), Economic Mission in Abidjan, (2001)**
- Food and Agriculture Organization (2010):** Global Forest Resource Assessment, Country Report Ethiopia. Forest Resources Assessment, FRA2010/065, Rome
- Freund, C., Wallich, C., (1997).** Public-sector price reforms in transition economies: who gains? Who loses? The case of household energy prices in Poland. *Economic Development and Cultural Change* 46 (1), 35–59.
- Gaffney Cliney & Associates Ltd (2007),** An assessment and opinion Statement regarding Natural Gas Reserves and supply Potential –Cote d'Ivoire
- Gaffney Cliney & Associates(1999),** Reserve naturelle de gaz et potential de reserve: Cote d'Ivoire
- Industry ministry Report, (2003)** Most of the data and statistics information have their source in the yearly report of the *Ministère de l'Industrie et du développement du secteur privé* (28-06-03)
- International Energy Agency (IEA), 2014.** Key World Energy Statistics, 2014 edition. IEA, Paris
- International Energy Agency(1998),** Natural Gas Pricing in Competitive Markets, Paris, OECD,
- Ministry of Environment and Sustainable Development, (1997)WHO (World Health Organization). 2010.** WHO Household energy database  
[www.who.int/indoorair/health\\_impacts/he\\_databasecont/en/index.html](http://www.who.int/indoorair/health_impacts/he_databasecont/en/index.html)
- UNDP (United Nations Development Programme) (2009)**The Energy Access Situation in Developing Countries
- WHO (World Health Organisation).( 2009).** The Energy Access Situation in Developing Countries. A Review Focusing on the Least Developed Countries and Sub-Saharan Africa.  
[www.who.int/indoorair/publications/energyaccesssituation/en/index.html](http://www.who.int/indoorair/publications/energyaccesssituation/en/index.html)