Management Summary

In the frame of the fight against deforestation, the reduction of energy dependence, and the reduction of greenhouse gas emissions, the UEMOA Commission intends to stimulate the development of the sectors that produce household fuels based on ethanol (gel fuel and/or ethanol) and/or biofuels (ethanol and biodiesel) in its region. The first phase of the project involves the execution of a regional study of the ethanol and biofuel sectors and markets.

The objectives of the current study are to determine and quantify market opportunities, to set up a supply system and the assessment of the technological, economic and financial feasibility of ethanol/gel fuel production units in the UEMOA region. In the member states with little potential to produce ethanol (from sugarcane, cashew tree and cassava), the possibilities of producing biodiesel from jatropha were evaluated.

Household fuel prices

In each of the UEMOA countries, a household energy market study was carried out with the aim of positioning ethanol-based fuels. Table X-1 gives an outline of the market prices of different fuels.

Table X-1 Price of woodfuels and fossil fuels in the UEMOA Member States

Country	Wood (FCFA/kg)	Charcoal (FCFA/kg)	Kerosene (FCFA/l)	Butane (FCFA/kg)	Gasoline (FCFA/l)	Gasoil (FCFA/l)
Benin	22	72	400	385	450	440
Burkina Faso	65	100	286	415	604	536
Ivory Coast	N/A	141	250	470	615	545
Guinea-Bissau	40	100	533	430	736	478
Mali	24	150	320	500	615	510
Niger	35	100	542	254	593	555
Senegal	N/A	150	276	439	648	555
Togo	25	74	280	375	525	515

Sources: Data collected by local experts, verified during field missions and completed with data from www.izf.net

The availability of suitable raw material

The potential for the production of (primary) ethanol and biodiesel was evaluated in terms of the availability of raw materials that could be valorised.

From a regional point of view, the agricultural production potential for the ethanol sector is very consistent with the geographical zones around the Niger, Senegal and Gambia rivers. A co-operation with sub-regional organisations charged with the development of these zones would enable setting projects in motion. It involves:

- OMVS (which includes Senegal, Mali, Mauritania and Guinea Conakry): the establishment of more than 600,000 hectares

- OMVG (which includes Senegal Gambia, Guinea Conakry and Guinea-Bissau): 50,000 hectares could be exploited.
- The Niger River Office in Mali: a minimum of 800,000 hectares.

The preliminary options for each country are the following:

- Benin - the most suitable raw material for the production of ethanol /gel fuel is cassava. With an average production of 2.8 million tonnes of cassava per annum, Benin could produce 20,000 m^3 of ethanol by using just 5% of harvests (no competition with food supply needs).
- Burkina Faso - sugar cane seems to be the most accessible raw material for the production of ethanol at present, based on new cultivations. If the 5,000 ha owned by SOSUCO were used for this purpose, one can reasonably estimate the production of ethanol at 20,000 m^3 per annum. The energy required for the conversion of sugar cane juice to ethanol could be provided by bagasse. Another potential source is the sugar sorghum if the plantation envisaged in the Sourou Valley becomes a reality. As for biofuels, SN CITEC (Dagris Group) plans to build a factory in the short term with a production capacity of 10,000 tonnes per annum based on cottonseed.
- Ivory Coast - the country has a large potential to produce ethanol as a result of extensive availability of cheap molasses, enabling the profitable production of ethanol, gel fuel and/or biofuel. The potential is 19,000 m^3/yr. Production costs are estimated at 121, 165 and 122 FCFA/l for ethanol, gel fuel and biofuel respectively.
- Guinea- Bissau - the cashew tree apple currently seems to be the most suitable raw material to use for the production of ethanol. The annual production is estimated at 400-600 thousand tonnes, of which only 30% are employed for the production of juice, wine and spirits. If the remaining 70% could be used to produce ethanol, the ethanol production potential would be approximately 8 400-12 600 m^3/yr.
- Mali - the real production potential depends mainly on the new sugar mill in Markala. The envisaged output of 170,000 tonnes of sugar per annum will result in an availability of 61,000 tonnes of molasses per annum, which can be converted into 18,000 m^3 of ethanol.
- Niger - the ethanol production potential is very low in Niger due to the absence of sugar cane production and low precipitation. However, there is particular interest to produce biodiesel from jatropha oil. Initial calculations based on cost estimates indicate that biodiesel could compete with (fossil) diesel.
- Senegal - the ethanol production potential in Senegal is considerable. The Senegalese Sugar Company (CSS) produces roughly 35,000 tonnes of molasses with a high sugar content per annum, which they plan to convert into 2,500 m^3 of industrial ethanol (96%) and 10,000 tonnes (12,500 m^3) of anhydrous ethanol for use as biofuel. As for biofuels several project promoters were identified.
- Togo - In spite of the presence of a small sugar industry, the immediate potential for the production of ethanol is low unless new sugar cane plantations are developed to replace industrial pineapple plantations. However, like in Niger, the private sector has particular interest to produce jatropha oil as a source for biodiesel. Initial calculations based on cost estimates of the various production factors indicate that biodiesel could compete (5% lower prices) with fossil) diesel. A point of attention remains nevertheless the competitive production of jatropha seeds.

Feasibility of ethanol production

Regarding the feasibility of ethanol as household fuel, Table X-2 shows the calculated price levels per MJ.

Table X-2 Prices per MJ of ethanol and household fuels

Country	Raw material	Ethanol	Real price of butane		Non-subsidised price of butane	
		(FCFA/MJ)	(FCFA/MJ)	(%) [a]	(FCFA/MJ)	(%) [a]
Benin	Cassava	17,8	8,7	103%	13,0	37%
Burkina Faso	Sugar cane	17,7	6,3	183%	12,7	39%
Ivory Coast	Molasses	9,1	5,5	67%	13,0	-30%
Guinea-Bissau	Cashew tree apples	25,2	11,7	117%	11,7	117%
Mali	Molasses	14,4	7,0	106%	12,0	20%
Senegal	Molasses	11,7	6,0	94%	12,6	-7%

[a] Price gap. The percentage shows how much more expensive (or cheaper) ethanol is.

The figures in Table X-2 indicate that under the current market conditions household fuels based on ethanol cannot compete with butane. The price levels of wood and charcoal, on an energy base, are definitely lower than those of butane, and are not included in the overview. The gel fuel production costs are generally 20 to 30% higher than those of ethanol, and are not included in the overview.

However, in Senegal and in Ivory Coast ethanol could compete with butane gas when subsidies on butane are eliminated (Senegal) or if equivalent subsidies would be introduced for ethanol. In addition, in all studied countries, the production of anhydrous ethanol (see X-3 Table below) for use as motor fuel would be more advantageous. In fact, according to the results of the financial analyses of this study, the value of ethanol as household fuel would be 36-70% below the value of ethanol as biofuel. Table X-3 shows production costs of biofuels (anhydrous ethanol and biodiesel).

Table X-3 Price per MJ of anhydrous ethanol, biodiesel and fossil fuels

Country	Raw material	Product	Price	Gasoline price	(%) [a]
			(FCFA/MJ)	(FCFA/MJ)	
Benin	Cassava	Anhydrous ethanol	15,0	13,6	11%
Burkina Faso	Sugarcane	Anhydrous ethanol	15,1	18,2	-17%
Ivory Coast	Molasses	Anhydrous ethanol	9,3	18,6	-50%
Guinea-Bissau	Cashew tree apples	Anhydrous ethanol	22,6	22,2	2%
Mali	Molasses	Anhydrous ethanol	12,2	18,6	-34%
Niger	Jatropha	Biodiesel		15,2 [b]	-11%
Senegal	Molasses	Anhydrous ethanol	10,2	19,5	-48%
Togo	Jatropha	Biodiesel		14,1 [b]	-5%

[a]Price gap. The percentage shows how much more expensive (or cheaper) ethanol (or biodiesel) is.
[b]Diesel.

With the exception of Benin and Guinea-Bissau the local production of anhydrous ethanol can compete with gasoline. Feasibility in Benin suffers especially from illegal import of hydrocarbons from Nigeria while production costs in Guinea-Bissau are high due to high raw material costs and low capacity utilisation as a result of the limited seasonal availability of cashew apple. In these countries, modest support measures (for example tax exemptions) could render the production of anhydrous ethanol viable.

On the other hand the production of anhydrous ethanol as fuel substitute for imported hydrocarbons should be especially stimulated in Ivory Coast (50%), Senegal (48%), Mali (34%), Burkina Faso (17%). These countries with important resources can save on the import of hydrocarbons, especially by developing local resources.

Regarding the production of biodiesel in Niger and Togo, preliminary calculations indicate that this fuel can compete with (fossil) diesel. Biodiesel production costs are 5 to 11% less than those of diesel. These costs are highly sensitive to the price of jatropha seeds.

All things considered, ethanol-based household fuels will only be able to compete with butane gas if a real(istic) policy with market introduction incentives is put into place in each country. Under all assumptions, other uses of ethanol such as biofuel will be much more profitable. Table X-4 summarises opportunities that are considered a « programme d'urgence » for short-term implementation.

Table X-4 Potential projects in the UEMOA countries

Country	Type project/ potential	Scale of units	Invesment	Remarks
Benin	20 000 m^3/yr ethanol based on cassava	1 000 - 10 000 m^3/yr	FCFA 337 Mio (small cut) FCFA 2.6 Mld (large cut)	Biofuel is 11% more expensive than gasoline)
Burkina Faso	20 000 m^3/yr ethanol based on sugarcane	20 000 m^3/yr	FCFA 5.3 Mld	Biofuel is 17% less expensive than gasoline
Ivory Coast	19 000 m^3/yr ethanol based on molasses	10 000, 5 000 et 4 000 m^3/yr	FCFA 2.1 Mld FCFA 1.2 Mld FCFA 966 Mio	Biofuel is 50% less expensive than gasoline
Guinea-Bissau	~10 000 m^3/yr ethanol based on cashew tree apples	1 000 m^3/yr	FCFA 652 Mio	Biofuel is 2% more expensive than gasoline
Mali	18 000 m^3/yr ethanol based on molasses	18 000 m^3/yr	FCFA 4.8 Mld	Biofuel is 34% less expensive than gasoline
Niger	Biodiesel based on jatropha	10 000 m^3/yr	FCFA 500 Mio (factory) FCFA 3.5 Mld (plantation)	Biodiesel is 11% less expensive than diesel
Senegal	15 000 m^3/yr ethanol based on molasses	15 000 m^3/yr	FCFA 3.2 Mld	Biofuel is 48% less expensive than gasoline
Togo	Biodiesel based on jatropha	10 000 m^3/yr	FCFA 500 Mio (factory) FCFA 3.5 Mld (plantation)	Biodiesel is 5% less expensive than diesel

Total General	**Ethanol (93 000 m^3/yr) et biodiesel (20 000 m^3/yr)**	**Ethanol : 1 000 - 20 000 m^3/yr ; Biodiesel : 10 000 m^3/a**	**Ethanol : FCFA 23.2 Mld (EUR 35,4 mio) Biodiesel : FCFA 8.0 Mld (EUR 12.2 Mio)**	**Substitution of 57,100 m^3 of gasoline and 19,000 m^3 of gasoil. Forex savings FCFA 20.6 Mld (EUR 31.4 mio)**

Recommendations

The principal recommendation is to continue the development of a biofuel sector in the UEMOA region. The potential to produce anhydrous ethanol and/or biodiesel starting from local raw materials is existing and promising in all the Member States. However, a strong will to reform the hydrocarbons sector and to take inciting measures enabling investments is necessary.

Specific recommendations for the steps to be followed are:

1. Organisation of a validation workshop, bringing together the owners of the identified projects; this should have the effect of drawing the attention of the public authorities and the financial institutions to the need to support the sector with financial and institutional incentives.

2. Adoption of Community directives to develop the market. The adoption of such directives would encourage the Member States to take appropriate legal and fiscal measures to promote the production and local consumption of biofuels.

3. Implementation of a support programme to promote awareness, to assist the private to carry out technical and financial feasibility studies and to prepare investment dossiers, to facilitate technology transfers and research & development at the level of local specialised institutes.

4. Implementation of real agro-energy policies aimed at the long-term development of the enormous assets in term of space available for the production of a large variety of feedstock species to produce ethanol and biofuel. This policy will also have to settle the land question in order to facilitate private investment. The World Bank, the European Union and the Government of Brazil could provide support.

5. Establishment of bioenergy sector development funds, intended to stimulate a favourable investment climate in the sector, and to provide direct finance to the private sector establishing production units. UEMOA could associate with the sub-regional financial institutions such as the West African Development Bank (BOAD) and the African Guarantee and Economic Co-operation Fund (FAGACE).

6. To envisage support activities and follow-up of the setting in motion of projects carried by the private and public sector aimed at the creation of a favourable market development climate. To this end, PRBE could be institutionalised in a sub-regional agency coordinating and stimulating the development of the bioenergy sector in the West African region.