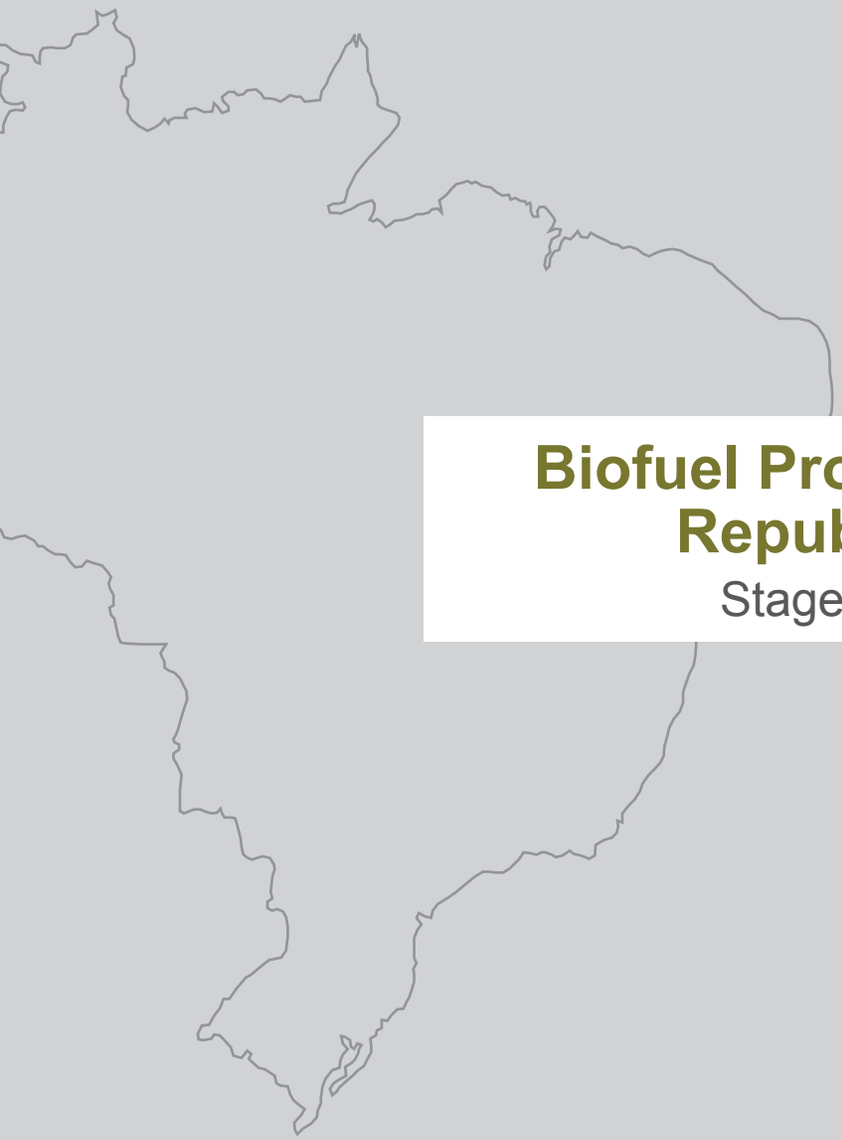
Biofuel Production in the Republic of Senegal

Stage 1: Feasibility Study

FGV PROJETOS

Summary of the Final Report of Stage 1

November 2010



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Contents

Introduction

Getulio Vargas Foundation, motivated by the memorandum of understanding between Brazil and the USA in 2007, has developed agroenergy projects in countries in Central America, the Caribbean and on the African continent.

Considering the knowledge and experience gained in these projects, FGV Projetos, at the request of the Ministry of Foreign Affairs, prepared an economic-financial-technical feasibility study for biofuel production in the Republic of Senegal.

The study herein identifies the potential regions for biofuel projects and selects promising projects for investment from the private sector.

The government of the Republic of Senegal is looking to set up its own legislation for biofuel production and use in order to obtain various benefits such as: investments from the private sector for ethanol and biodiesel production, reducing pollutant gases, economizing in the balance of payments by reducing fossil fuel imports, rehabilitating degraded arable areas and so on.

The study reinforces the feasibility of introducing biofuels into the Senegal energy matrix and the capacity to attract private investment, boosting the generation of wealth and income distribution primarily by increasing the monetary circulation in the economy; namely, part of the remittances used to pay the petroleum or gasoline/diesel account will now circulate on the local market.

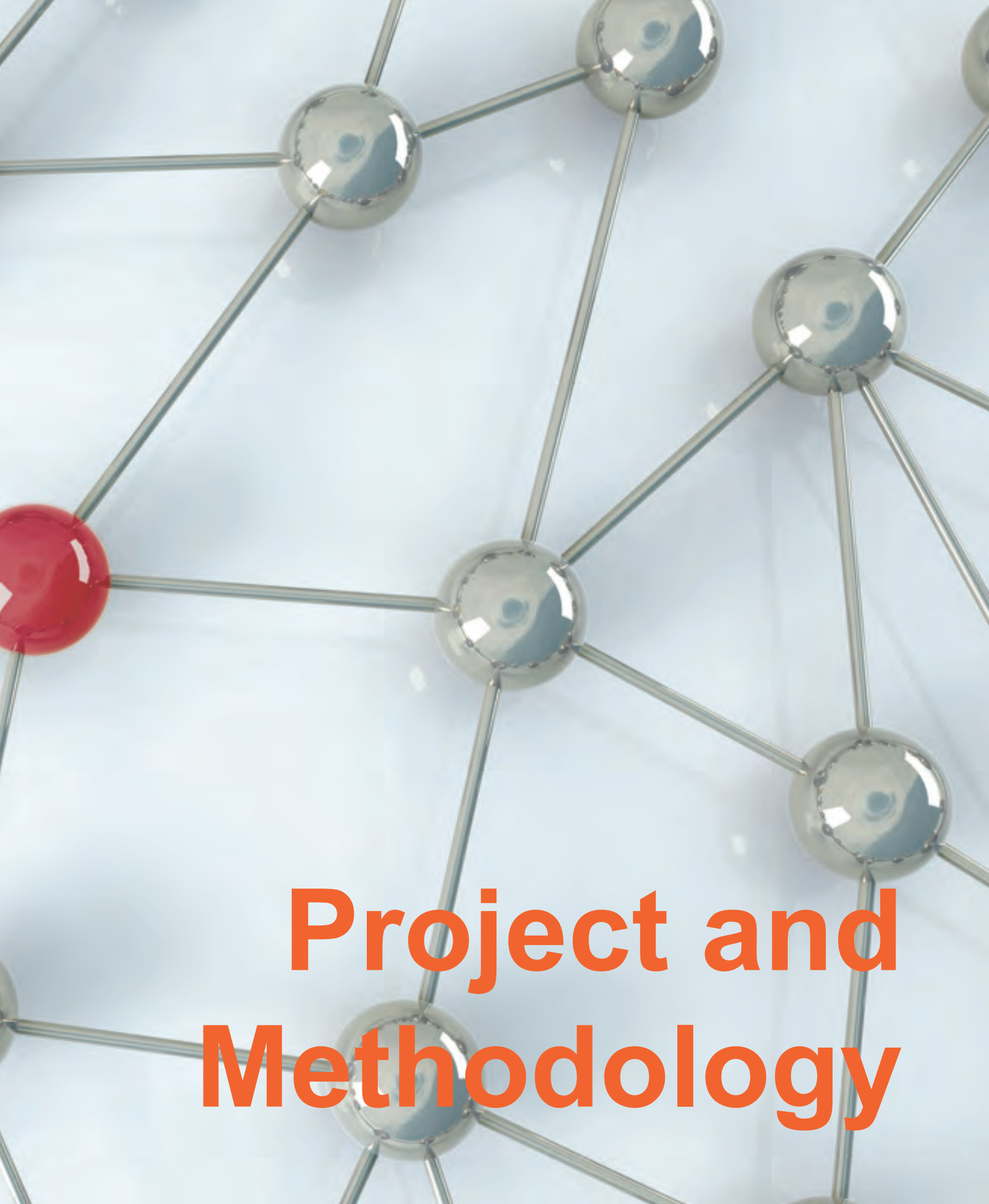
The biofuel industry is also characterized by the capacity to develop the overall farming sector where the main raw materials for biofuels are produced. Investments in farming

equipment and machinery, developing new plant varieties, strengthening the fertilizer and defensive market and introducing best management practices are some examples of this development that helps the farming sector and food production.

Africa, in turn, is emerging as a promising large-scale biofuel producer, considering the existence of large areas of arable land, the tropical climate and available manpower. Notably, the continent depends heavily on petroleum and its byproducts, and sustainable alternatives such as biofuels, with high job generation and income distribution capacity that seem to be ideal solutions for many African countries.

Getulio Vargas Foundation is aware of how important the biofuel sector is as a major tool to leverage developing economies and has been making efforts to produce and convey knowledge through the economic-financial-technical feasibility studies for biofuel production, showing its feasibility and effective contribution to reducing poverty in addition to providing the other aforementioned benefits.

Cesar Cunha Campos
CEO
FGV Projetos

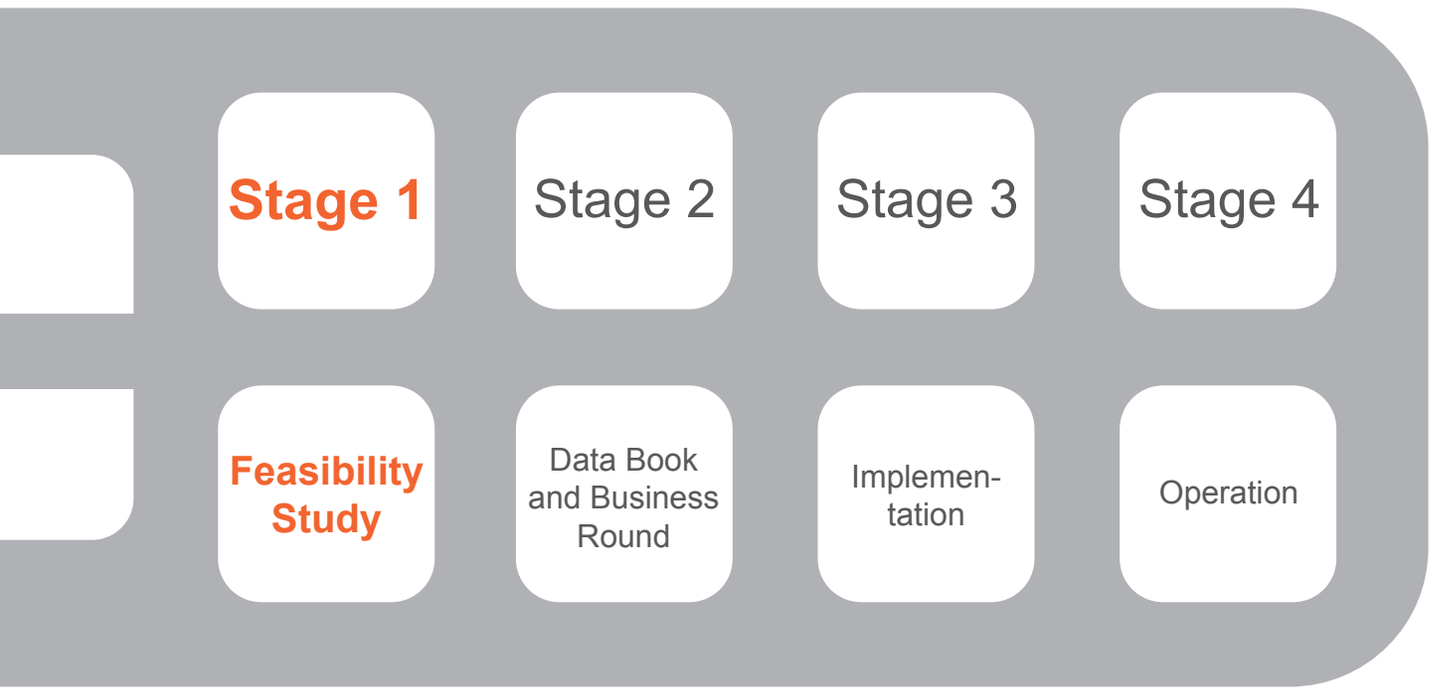


Project and Methodology

The economic-financial-technical feasibility study for biofuel production in Senegal adopts a model idealized by FGV Projetos, the result of experience accumulated over

the past 30 years, and which considers the particular characteristics of each country. It points to clear objective continuity for attracting investments needed to carry out the selected projects.

Methodology



Stage 1
Feasibility Study

The first stage in the biofuel promotion program consists of preparing an economic-financial-technical feasibility study that, by analyzing the economic, physical, socio-environmental and structural aspects of the whole country, provides suggestions of biofuel production and bioenergy generation projects, depending on their feasibility for implementation. Stage 1, the feasibility study, which is the subject of this publication, is divided into four key topics, as follows:

Capacity to produce and recommend feedstock;

Study of the socioeconomic aspects and recommendation of business models;

Analysis of economic-financial feasibility study for possible new projects; and

Guide to implementing bioenergy projects and recommendations to the government.

Stage 2
Data Book and Business Round

This stage consists of two steps: preparing a Data Book and a Business Round. The Data Book consists of a complete compendium containing all information and detailed instructions required for implementing the projects mentioned in Stage 1, and enough to minimize risks perceived by potential investors.

Data Book contents – Detailed projects for the different topics below:

- Farming;
- Industrial;
- Legal;
- Environmental;
- Social;
- Financial and economic (including sources of funds); and
- Transfer of technology and know-how.

The contents of this stage are focused on investors interested in bioenergy projects in Senegal. To achieve this, Business Rounds are planned and organized with the support of the Senegalese, Brazilian and US governments to present the projects to private investors.

Stage 3
Implementation

It consists of the selected investor implementing the projects. At this stage the plan is to set up a multidisciplinary technical team from Getulio Vargas Foundation that will undertake audits and communication with government specialists and those responsible for investment to guarantee involvement of the main stakeholders.

Stage 4
Operation

The operating stage basically involving the farming and industrial production will be the responsibility of the selected investor.

Stage1

Economic-Financial-Technical Feasibility Study

Republic of Senegal

Production capacity is analyzed and raw materials recommended. This analysis begins with studies about the country's energy matrix in order to understand its performance over the years and identify opportunities for diversity and the shortages to be overcome by the possible projects.

Next, in order to recommend feedstock with the highest potential performance, agricultural crops are zoned according to different criteria, which result in aptitude maps.

The criteria adopted when preparing the zoning involve various aspects, such as past data from meteorological stations, soil data, relief, composition mapping, and so on.

Accordingly, FGV Projetos looks to define crops that have a farming aptitude, whose yields justify their use for industrial processing.

Then socioeconomic studies of the country are carried out, addressing key issues for the success of the projects, such as land tenure, demographic aspects, tax questions and environmental and labor laws. The study of these topics helps adapt the more interesting business models suitable for each region recommended for new projects.

After defining feedstock and more apt regions, and having completed the socioeconomic studies, the economic-financial feasibility studies of possible new projects are undertaken. At this stage, the projects are in more detail, indicating the total area used, business model, crop installation and management, industrial aspects, labor used, expected production, and so on, to enable analysis of total costs, investments and earnings, resulting in an economic-financial feasibility analysis.

Lastly, based on the projects and business models in question, recommendations are suggested to the local government to help implement the projects. These recommendations include labor, land tenure and legal and technical aspects on the biofuels to be produced.

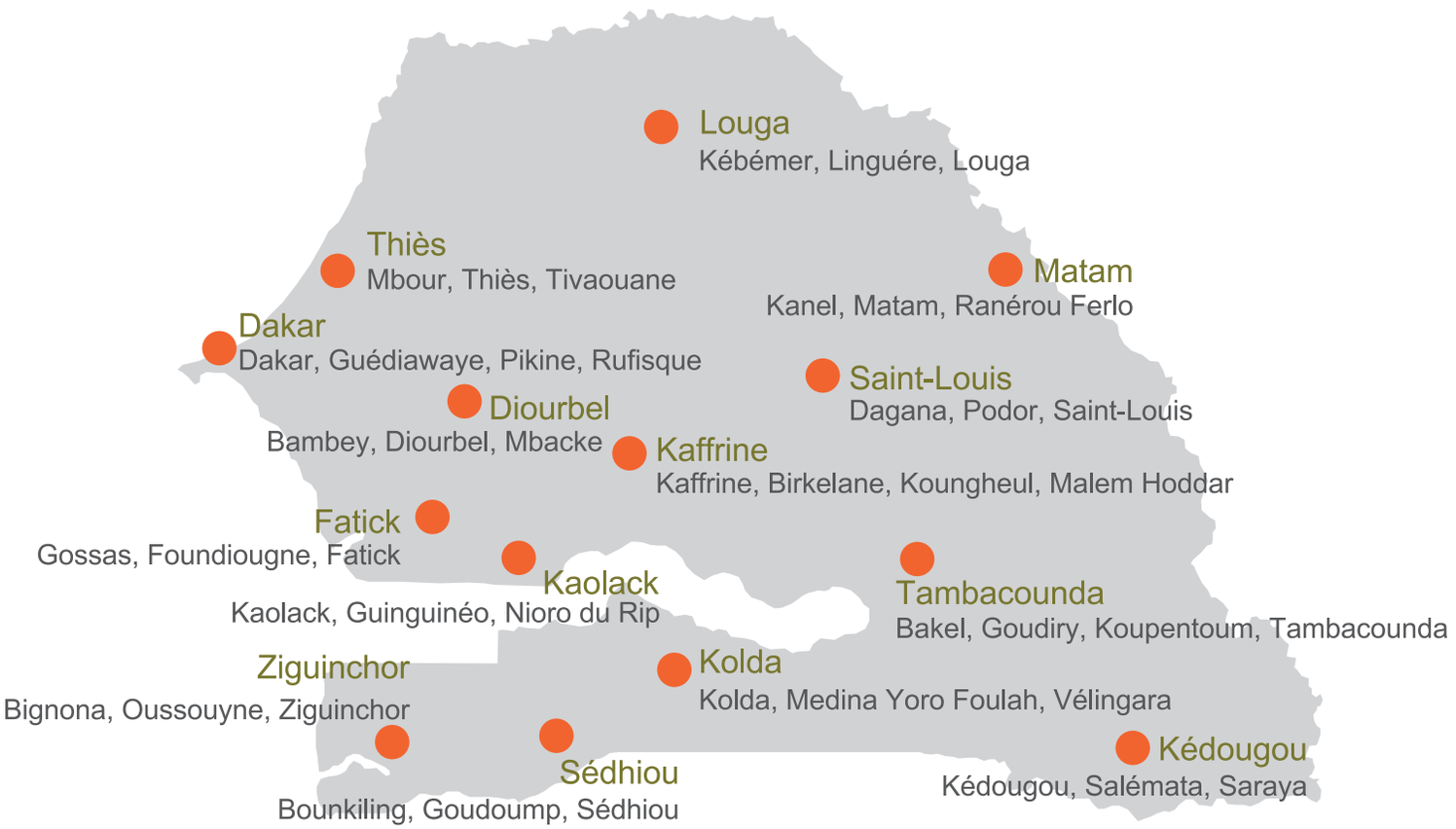
Republic of Senegal

The Republic of Senegal is situated in the African continent, the local language is French. Senegal's economy is now very diversified, based mostly on fishing and mining, mainly calcium phosphate. The country is a member of the Economic and Monetary Union of West Africa (EMUWA), which uses the CFA franc as common currency and one of its main goals is to reinforce the economic competitiveness of the member countries.

The country's farming sector is still not very developed, mainly focusing on subsistence farming. Senegal is a net food importer.

GDP (USD)	Population (inhabitants)	Total area (km²)	GPP per capita (USD)	HDI
13.2 milliards	12,543,200	196,720	1,000	0.436

Since 1982, the country is divided into regional governments, which together form a group of 34 municipalities.



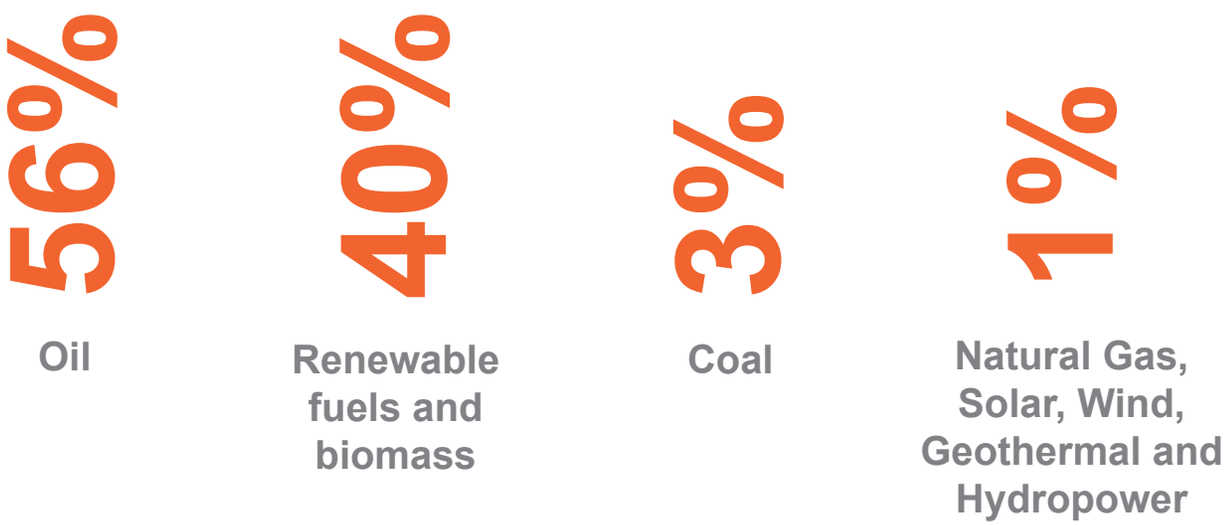
Energy Matrix

Senegal's energy matrix depends too heavily on firewood or charcoal and petroleum byproducts that represent 50% of all energy consumed in the country.

Firewood or charcoal is used primarily as a source of energy for cooking food and mostly comes from native areas, accentuating deforestation throughout the country

FIGURE 1

Composition of the energy matrix of Senegal, 2006

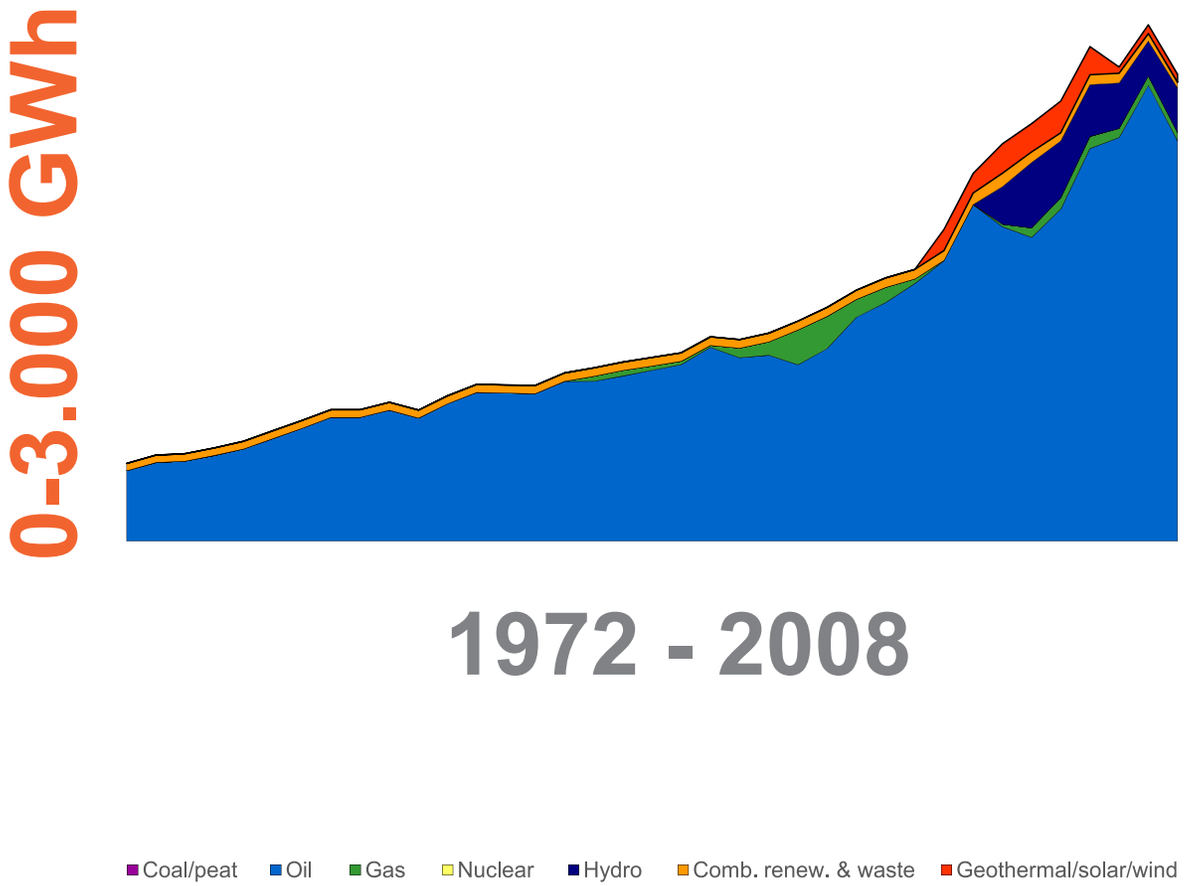


Source: IEA, 2010.

Fossil fuels not only supply the transportation sector but are also used to produce electricity. Practically 90% of all electricity consumed in Senegal comes from burning diesel fuel.

FIGURE 2

Electricity generation by fuel



Source : IEA, 2010

Logistics infrastructure

The road system is the country's main means of transportation. The highway network is denser on the western coast, principally near the capital Dakar and cities such as Thiès, Diourbel and Fatick. There are fewer road further inland, which may hinder the production flow through the mid-eastern part of the country.

In terms of air travel, there are 19 airport or aerodrome facilities, ten of which have paved runways. The three international airports are Dakar, Saint-Louis and Ziguinchor. The Leopold Sedar Senghor international airport of Dakar concentrates most of the air traffic due to its capacity to receive all kinds of aircraft and it is the first airport in the Economic Community of West African States (ECOWAS).

Senegal has four ports: Dakar, Lyndiane, Kaolack and Ziguinchor. The country's main export operations are concentrated in the port of Dakar, with the others considered secondary.

The port of Dakar has 10km of quays and 40 berths for cargo ships, among other facilities, and is in a privileged location: at the tip of the West African coast, where the sea routes cross between Europe, North America, Latin America and Africa, covering an area of more than 3,260,000 m².

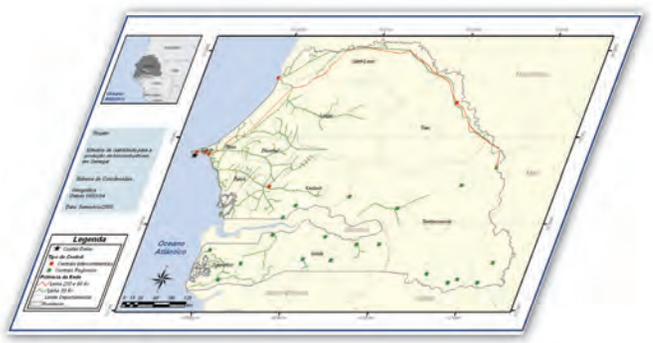
FIGURE 3

Transportation Network System

Source: FGV Projetos, 2009

FIGURE 4

Energy networks



Source: FGV Projetos, 2009

General characterization of Senegal's climate

The country has basically three different climate zones: coastal, Sahelian and Sudanic.

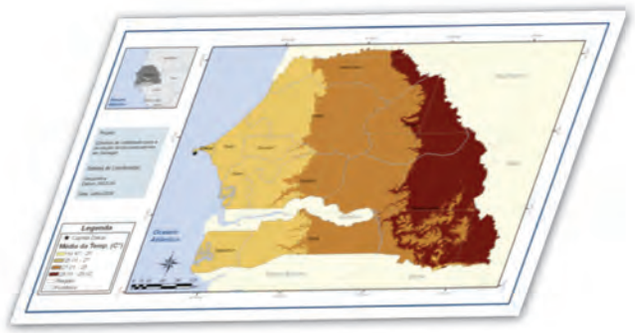
The coastal zone stretches all along the Atlantic coast from Saint Louis to Dakar and has a mild winter with minimum temperatures of 17°C in January, and summer temperatures not very high, the maximum being 27°C or below. Annual average rainfall is 500mm, concentrated between June and October.

The Sahelian climate is found in the northern part of the country. The climate is mild in winter but there are months when the minimum is above 22ºC and maximum temperatures often reach 40°C. The dry season is clearly defined between November and May. Rainfall in the wet season from July to October is not much more than 360 mm.

The Sudanic zone in the southern half of the country is generally hot and wet, but has a well-defined dry season. Annual rainfall varies from north to south of this zone, from around 740 to 1,270 mm. In the far South around Casamcane, the annual rainfall is over 1,270 mm, hence the thicker forests and cultivation of perennial crops.

FIGURE 5

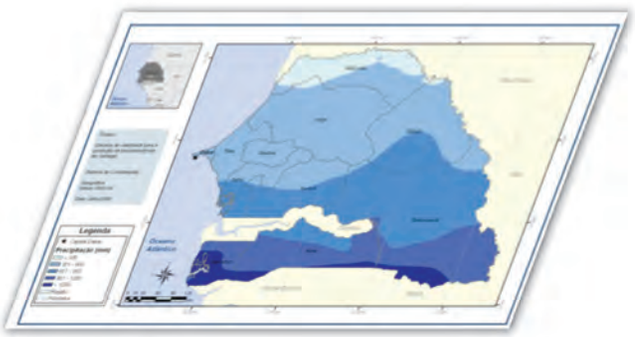
Annual average temperature



Source: FGV Projetos, 2009.

FIGURE 6

Annual average rainfall



Source: FGV Projetos, 2009.

Feedstock recommendations

Adopting the aforementioned methodology, feedstock is first indicated by preparing the agroclimate zoning maps for the following crops: sugarcane, elephant grass, sunflower, eucalyptus, cotton, African palm and *Jatropha curcas L*.

These maps are drawn by combining climate maps (potential evapotranspiration (PET), actual evapotranspiration (AET), water deficit (DEF), water surplus (EXC), annual average temperature (Ta), average temperature of the coldest month (Tcold), annual average rainfall (P), and so on) and the climate requirements for each crop.

By means of this zoning, African palm growing was discarded since the country had no area that would meet the full or partial climate requirements of this crop for commercial production purposes.

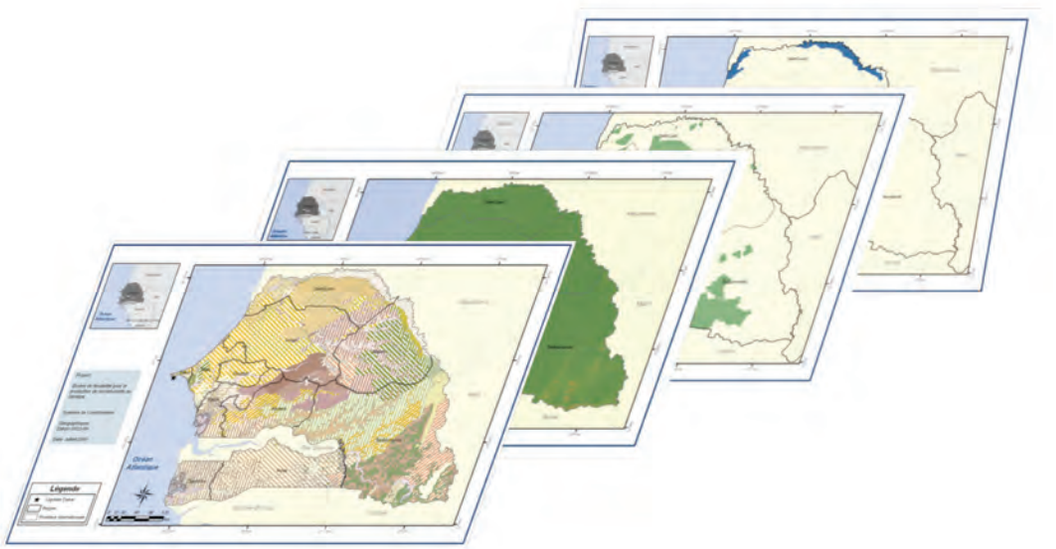
With the other crops, the land capacity zoning was prepared by comparing the edafic requirements with soil data, wet zones, protected areas and slope.

Lastly, by combining the agroclimate zoning and land capacity map the macro-regions could be defined with greater agricultural aptitude for the crops studied.

Since the *Jatropha curcas L*. crop is still not widely explored commercially, there are no well-developed technological packages for its production, and it is therefore not interesting to recommend projects at this moment. The maps show the government possible local potential for projects, if the crop's productive potential is confirmed in the next few years.

Therefore, to define regions of interest, sugarcane, elephant grass, sunflower, eucalyptus and cotton growing was considered. The macro-regions were defined according to the farming potential (areas with highest aptitude) and the possibility of expanding projects.

Maps

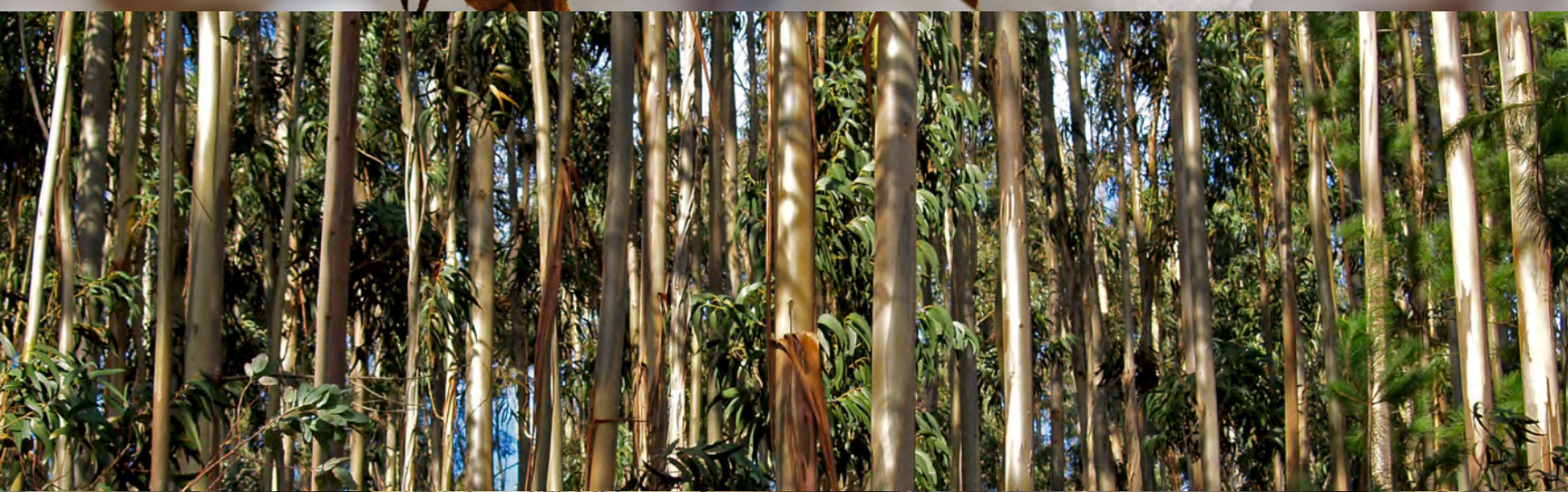


Source: FGV Projetos, 2009.

In accordance with the field check and information about the regions of interest, it was possible to define the crops recommended for projects. It was found that growing elephant grass would need irrigation in the same macro-regions of a possible sugarcane project, which is why it was discarded. Accordingly, the crops for preparing projects were defined as follows:

- Sunflower
- Cotton
- Eucalyptus
- Sugarcane

The last step was to choose the macro-region most indicated for each crop from among the macro-regions in the study. The choice took into account aspects such as competition, possible expansion and replication of projects, planting food crops (which must be preserved) in nearby areas, and so on.



Study of land tenure

Land tenure is mainly organized at a local level through rural communities. In this model guided by the Senegalese traditional socio-cultural habits, human groups settle in villages, with irregular housing layout, and allocated close to the most important local resources, namely roads and water bodies.

The resource of arable land available in Senegal is as follows:

TABLE 1

Use of farm land in Senegal

Type	Area (ha)	%
Arable areas	3,737,680	19
Protected areas	6,295,040	32
Non-arable areas	9,619,280	49
Total area of the country	19,672,000	100

Source: (MEPNBRLA & République du Sénégal 2009), adapted by FGV Projetos, 2010

Fifty-seven percent of the 19% of Senegal land is considered suitable for agriculture and lies in the region of the peanut production basin, with only 10% in the eastern part of the country.

The rights to use the land for construction and agriculture are distributed by local leaders who may be represented by individuals or small groups. The size and location of the areas allocated to each family or use are also decided by local leaders, always respecting the boundaries of the counties attributed by the State.

Approximately 51% of farmers have 16% of the cultivated land, divided into properties of three hectares or less. The farmers, however, who have 10 hectares or more (9.25% of the total) have access to 33% of arable land, showing the unequal distribution of this resource.

Findings show that the policies of transferring administrative power to the local spheres have positive results, but require a further degree of investment in building the capacity of the agents involved, as well as inspection and registration of such operations.

Labor and tax aspects

Senegal is considered an example of tax discipline on the African continent, considering the small tax deficit in recent years. Taking into account that strengthening tax management is the key to achieving further growth and reducing poverty, key reforms in Senegal's public finances have been made. As part of the growth and poverty-reducing strategy, Senegal began a tax decentralization process and return of expenses and earnings. The starting point involved two major reforms in the peanut sector, with the sale of the state peanut processing company and eliminating tax and tariff benefits that protected the sector and, principally, the state company.

Net income taxation

Income tax – annual rate of 33% on net profit of commercial, farming and Industrial activities during the previous year by companies and other legal entities. The following are exempt: consumer cooperatives, farming credit agencies, farming insurance companies, mutual aid associations, rural administration and development associations, non-profit associations and organizations, public administration.

Minimum presumed corporate tax – annual sum, fixed in relation to the net charge on the previous year's business volume.

Tax on individual earnings – there are three different charges: the proportional tax and gradual tax of 11% (for wages above 600,000 CFA francs); land yield and buildings of 20%; commercial, farming and industrial profits of 25% (for profits above 600,000 CFA francs).

General individual contribution – applicable to companies whose business volume does not exceed 50 million CFA francs. For these companies it substitutes five taxes (tax on earnings, minimum presumed tax, license charges, VAT, and the employer's payroll tax). The charges vary from 5,000 to 4,200,000 CFA francs, according to the business volume.

The employer's payroll tax – is charged on total wages, paid earnings and subsidies; 3% on wages paid to the Senegalese and 6% on wages paid to foreigners.

Property tax – property tax, ownership transfer charge and stamp tax may be charged on implementing biofuel projects.

Tax on goods and services

Value added tax – charged on any business relating to an economic activity, except for farm production and wage-earning activities. It is a single charge of 18%.

Special consumer tax – charged on petroleum byproducts. The charges are collected for every hundred liters and vary from 3,856 to 20,665 CFA francs.

Insurance contract tax – charged on insurances and expenses relating to the insurance company. The charges vary from 0.25% to 20%, and are eliminated in cases of life insurance or similar products.

Business licensing charges – the patents are charged annually on any individual relating to commerce, industry or any professional activity. The license is collected annually from every individual or company relating to the sale of alcoholic beverages. Recently established industries are exempt of the patents for the first five years. Also exempt are craftsmen, fishermen and farmers.

Foreign trade tax

Customs duties – The duties can vary between 0% and 20%, depending on the category of products.

Tax statistics – collected on imports from third countries, exempt or non-exempt alike. The charge is 1%.

Community solidarity collection – this is a payment to the central government on goods originating in other countries, at a normal rate of 1%.

Exports and imports – To procure feedstock or products of any kind for industrial requirements or even for a farm a special card must be obtained – the importer/exporter's card (Art. 78 of the Customs Code) issued by the Ministry of Trade. Pursuant to art. 69 of the Customs Code, all imports or exports must be accounted for, under customs regulations. The accounts must be presented in a customs house to open the proposed transaction. Imported or exported goods must be accounted by their owners who receive a removal credit with approval from the customs agent or entry authority under Code conditions.

Base calculation on wage contributions – the contribution base is on the total value of the remuneration, the ceiling and floor taxable at 60,000 and 36,245 CFA francs, respectively, and the contribution charges varying from 1.3% to 7%.

Tax incentives – there is a tax incentive package for investments provided in the General Tax Code (GTC) for the economic development of the country. The benefits described in the Code include exemption from contribution and special benefits on income tax for new companies.

In the labor sector, article L. 135 regulates a legal 40-hour a week maximum, except in farming activities, which have a limit of 2,352 hours a year.

The hours worked beyond the limit must have 15% overtime (up to 48 hours), 40% (over 48 hours) or 60% (nighttime). For some sectors (farming, trade and hotels) or occupations (drivers, guards and employees) an equivalence system allows longer working hours with no extra pay.

The minimum wage is 36,245 CFA francs, but the average earnings of employees may vary between 209.10 CFA francs per hour for such sectors as industry, commerce,

services, and 175.1 CFA francs per hour for the farming sector. The main social charges are the Social Security Fund (CSS) and contribution pensions (iPRES).

The labor market consists mainly of male labor, over 40 years old and with a low level of education and skills.

Economic-financial feasibility analysis of possible new projects

Places for implementing the projects and the possible expansion areas were indicated after analysis of the macro-regions.

Three projects and one pilot experiment are recommended.

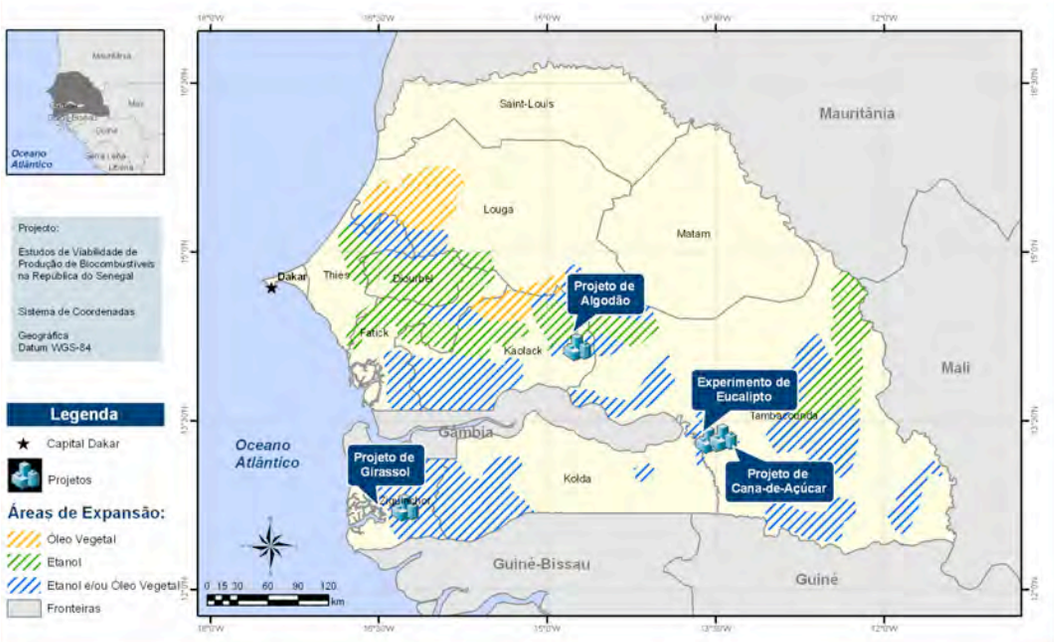
The sugarcane ethanol project was indicated for Missirah community, in the Tambacounda department. The total occupied area will be approximately 3,700 hectares, 3,000 of which are for effective sugarcane plantations. The area allocated for effective cropping will be divided into five equal units, each implemented in one year.

The soy and sunflower oil project was recommended for the Ziguinchor region in the Bignona department. The total area occupied will be around 2,554 hectares, 2,520 of which are for raw material production, being divided into 1,680 hectares for sunflowers and 840 hectares for soy. The area for actual planting will be divided into seven equal plots of farming land (glebes) of around 364 hectares each and all glebes will be implemented within three years.

The cotton oil project was recommended for the Kaolack region in the Koungheul department. The total area occupied will be approximately 3,600 hectares in a crop rotation system. The area allocated for actual planting will be divided into four equal modules (900 hectares each), all modules being implemented in the first year.
The eucalyptus biomass experiment was recommended for the district of Missirah in the Tambacounda department. The total area occupied will be around four hectares plus an area for seedlings.

FIGURE 7

Location of the recommended projects and potential areas for new projects



Source: FGV Projetos, 2010.

Socio-environmental sustainability

The recommended projects adopt the concept of socio-environmental sustainability, in order to guarantee conservation of the natural resources in the region where they are allocated, and at the same time further economic and social development in the regions.

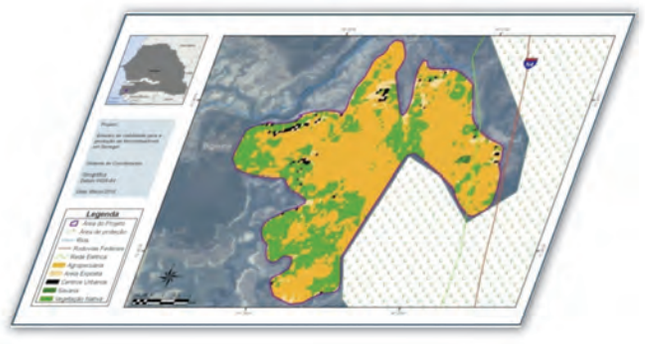
To do this, a detailed assessment, with the help of remote sensing resources, was carried out on land use in the area recommended for implementing the projects. The main objective was to discover the unmentioned ecologically sensitive areas (environmental protection, native vegetation, banks of water courses, and so on).

The predominant biome in Senegal is savanna land, characterized by the presence of grass, sparse trees and small isolated groups of bushes. The team found on their field check that some areas of this biome are altered by human action, today without the original native vegetation, and often used for farming, and it is possible to indicate projects in areas belonging to this class.

To spacialize the area available for the projects and separate it from the other areas of native vegetation, maps were prepared of urban zones and protected areas, land use and occupation for each project's region, as in the following example.

FIGURE 8

Use and area occupancy in the sunflower project



Source: FGV Projetos, 2009.

In general, except for the sugarcane project, water is not used for project irrigation. The region chosen for the sugarcane project has the highest rainfall in Senegal to assure that as little water as possible will be used for irrigation, and only to complement the water requirements of the crop, not characterizing the concept of full irrigation. Therefore, it is guaranteed that the water volume used in irrigation (85,000 m3 a day, on average) is only 0.77% of all mobilizable water from the Gambia River planned by the Senegal Ministry of Agriculture.

TABLE 2

Available water estimate

River	Average Mobilizable Potential (m^3/jour)
Senegal	38.350.000
Gambia	11.000.000
Casamance	355.000

FGV Projetos, 2010 (adapted from GOANA, 2008)

In relation to cropping methods, great care is taken to recommend the minimum possible mechanized tillage in order to conserve it more adequately. Fertilization is calculated taking into account the use of waste, which guarantees less use of chemical fertilizers. Moreover, when possible, crop rotation practice is recommended to interrupt the cycle of pests and disease and not to expose the soil, and it is planned to pay bonuses to farmers who correctly adopt conservationist practices.

In the social sphere, the projects aim to involve the community dwellers, who must be the primary source of labor in every process. The working hours were all provided within the limits stated in Article L. 135 of the Labor Code and the minimum remuneration corresponds to a minimum wage plus charges and benefits. The workers must be

assured medical care, as well as the mandatory use of individual protective equipment (IPE) whenever necessary.

The idea is to work in cooperatives, involving those already in existence or reviving the old systems in order to also benefit other farm crops, increasing the income in the region and encouraging people to stay in the countryside. Also, the intended practice of crop rotation and paying bonuses to farmers who correctly adopt conservationist practices must also result in increased income.

The increased power supply through the projects should attract more investments for the regions. One of the objectives in Stage 2 of the project is to find and structure solutions to guarantee effective generation of wealth and income demonstrated in Stage 1 – Feasibility Study.

Business models

The purpose of the developed business models is to integrate the communities in the projects and guarantee that they will most benefit.

In the cotton project, production and processing of the raw material is planned within the communities. After processing, the fiber, which is the major source of income, must be sold. The cottonseed must be crushed, separating the husk and oil. The oil can be used as fuel for power generation in the community and supplying internal processes, while the husk should be used to feed small livestock. An increase in the community dwellers' consumption of animal protein can then be guaranteed. All animal slurry and production waste may be used as fertilizers, and therefore complete the chain.

The soy and sunflower project has a similar model, with grain production, which will be crushed in a small community-run plant. The resulting oil and bran can be sold to increase income and some of it can be used as described in the cotton project model.

The sugarcane project is designed for ethanol production, which can be used in various ways (car fuel, domestic use, power generation, etc.). One interesting use is to transform it into alcohol gel, designed for small domestic stoves, substituting firewood for cooking. In addition, an integrated project was recommended that permits power generation by means of a hybrid solar system using ethanol or waste from its production on cloudy days or at night. Power generation is recommended through cogeneration, by burning bagasse waste while the vinasse and filter cake will be used in the fields.

Cotton

Available area: 3,600 ha
Managed area: 3.600 ha
Production: fiber – 3060 t/year; oil – 1065 t/year; cake – 4695 t/year
Investment required: US$ 7 million
IRR: 18%
Option to replicate the project for neighboring and other apt regions

Sunflower and Soy

Available area: 2554 ha
Managed area: 2554 ha
Production: oil – 1800 t/year; bran – 3400 t/year
Investment required: US$ 5 million
IRR: 12% (farming), 15% (industry)
Option of replicating the project for neighboring and other apt regions

Sugarcane

Available area: 6680 ha
Managed area: 3700 ha
Production: 28,000,000 L anhydrous ethanol p.a.
Investment required: US$ 72 million
IRR: 22%
Integrated option: up to 325 solar modules with 1MW capacity

Eucalyptus and Acacia

Area occupied by experiment: 4 ha
Experiment to indicate more efficient spacing and more suitable basic management for commercial production of *E. camaldulensis* and *A. senegal.*

Guide to implementing bioenergy projects and recommendations for the government

In conclusion of Stage 1 – Feasibility study, the Guide was prepared to implement bioenergy projects and for recommendations to the Republic of Senegal's government.
The purpose of this guide is to provide the steps to implement the aforementioned and similar projects, involving regulatory benchmarks, technical fuel specifications, tax incentives, land tenure structure and a list of machinery and equipment suppliers.

The regulatory benchmark shall address the different goals in a long-term timetable that can meet immediate demand and plan for alternatives and future opportunities.

Thus, in addition to increasing the supply capacity of the home fuel and energy market through an economically, environmentally and socially sustainable matrix, the benchmark must foresee the country's capacity to produce surplus in the near future, in order to make international biofuel trade feasible with related energy and technologies .

In the rural electricity sector, the country has already done a lot to encourage power generation and distribution through private enterprise. However, it will be necessary to review the content of the legislation in force, since new sources and markets will be opened as a result of the proposed projects.

Energy cogeneration systems, for example, require a review of the elements in Law no. 98-29 referring to the electricity sector and the new law for biofuels.
The Regulatory Committee for the Electricity Sector will be responsible for guaranteeing a healthy environment for the entry of cogenerated power into the market, primarily in areas under concession of the private sector, which include:

- Establishing minimum price control mechanisms for energy;
- Guarantees for surplus energy procurement by SENELEC; and
- Recognizing cogeneration activities as suitable for the Rural Electrification Funds, especially implementing energy distribution systems.

Considering the projects proposed in this paper, it is possible to offer estimates for automobile fuel mixes sold in Senegal.

TABLE 3
Estimated biofuel production from recommended projects

Project	Gross production	Fuel production
Sugarcane ethanol	28,000 m^3/year	28,000 m^3/year
Sunflower oil	1,420 t/year	1,636 m^3/year
Soy oil	410 t/year	476 m^3/year
Cotton oil	1,064 t/year	1,235 m^3/year

Source: FGV Projetos, 2010.

Some scenarios may be achieved with regard to the inclusion of ethanol in the Senegalese market by mixing with regular gasoline, based on the production values foreseen in the recommended sugarcane ethanol project:

TABLE 4
Market supply forecast of gasoline-ethanol mix in Senegal

Mix	Gasoline (m^3)		Ethanol (m^3)		Fuel available for consumption (m3)
E0	111,000	100%	-	0%	111,000
Project	-	-	28,000	25.2%	111,000
E10	99,900	90%	11,100	10%	111,000
E25	83,250	75%	27,750	25%	111,000

Source: IEA 2008, adapted by FGV Projetos, 2010

In a hypothetical scenario in which the recommended oilseed production would be allocated to biodiesel production for supplying the home market, the figures would be as follows:

TABLE 5
Market supply forecast of biodiesel-diesel mix in Senegal

Mix	Diesel (m^3)		Biodiesel (m^3)		Fuel available for consumption (m3)
B0	450,000	100%	-	0%	450,000
Project	446,653	99.26%	3,347	0.74%	450,000
B2	442,000	98%	9,000	2%	450,000
E5	427,500	95%	22,500	5%	450,000

Source: IEA 2008, adapted by FGV Projetos

We must remember that oilseed projects are easily replicable and may be implemented to meet the increases in demand decided by the government.

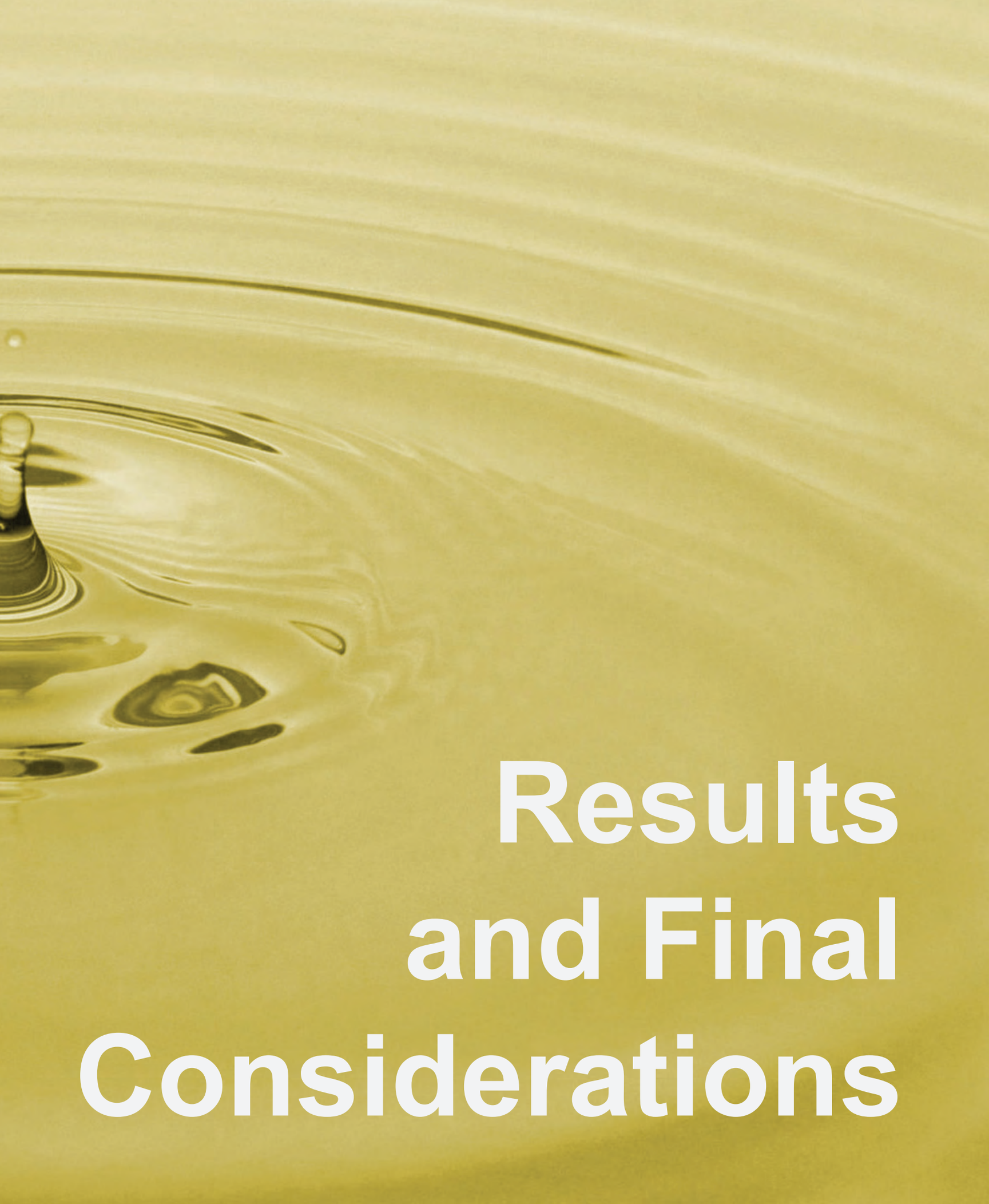
In relation to incentives and exemptions provided in these laws, inclusion of the following items could be considered:

- To consider that, in terms of tourism in Senegal, it is important to adopt the use of clean energies as an ecological attraction, increasing the potential of ecotourism through an effective investment program in infrastructure and capacity building of the sector's agents;

- To consider that the guarantees of stability and balance in the economic scenario of the chain of renewable energies must come from the national policies for the sector. To do this, it is recommended that independent and autonomous agencies be created that can oversee and regulate the main critical points in the chains, such as price preparation, retail and wholesale trade, quality control and standardization, fund management and credit services for consolidating and expanding the sector;

- To guarantee public investments and opening for private investments in developing national industry focusing on supplying the chain in order to maximize development and reduce dependence on foreign inputs, technologies and services; and

- To guarantee public investments and opening for private investments in academic and scientific development in order to provide for the capacity building and specialization of local manpower.



Results and Final Considerations

Stage 1 – Economic-social-technical feasibility study has allowed the FGV team to make a detailed diagnosis on the current status of Senegal from different aspects that have direct impact on implementing bioenergy projects, and to indicate the most suitable crops, regions and business models for the country.

The analysis of the energy matrix has shown that the country depends heavily on petroleum, indicating the potential for biofuels to join the Senegalese market. The regions involved in the study have considerable available labor in the farming sector to set up biofuel projects and the country has a series of innovations in terms of both tax reform and the investment code, designed to encourage private investment in strategic sectors.

The studies in the selected regions have helped to indicate three bioenergy projects and one field experiment, as follows:

- Sugarcane ethanol;
- Soy and sunflower oil;
- Cotton oil; and
- Eucalyptus and acacia biomass.

All proposed projects have as a premise the concept of economic, environmental and social sustainability and, since they are all linked to the farming sector, they could increase rural development and fix people in the countryside, contributing to reducing immigration. They were also economically feasible and attractive, with higher internal return rates than the minimum rates of attractiveness and positive net present values for the periods of time considered.

The following are recommendations to assure the success of projects of this kind:

- for the government to encourage policies of access to electricity, parallel to incentives for alternative energy production;

- for the human resources required to implement and carry out the projects be duly skilled for the defined functions;

- for investments be made to expand the service centers and also to combat the main diseases affecting the country;

- to guarantee an efficient basic service system, namely sanitation, garbage collection, energy network and so on;

- for village leaders and farmers to be directly involved in the processes;

- to offer technical assistance for production farming, not restricted only to energy crops;

- to encourage the formation of formal groups of farmers, such as cooperatives or associations, especially for procurement or development of micro-credit services; and

- to encourage environmental rehabilitation and conservation.

Staff

TECHNICAL STAFF

Project Director
Cesar Cunha Campos

Project Supervisor
Ricardo Simonsen

Project Coordinator
Cleber Lima Guarany

Technical Orientation
Roberto Rodrigues
Cecilia Fagan

Technical Coordinator
Giuliano Marchini Senatore

Technical Team
André Vogel Filisetti, Bruno Casagranda Neves, Fellipi de Moraes Rustici, Flávio Rodrigues Cabrera, Giselle Teles, Martin Hoffmann and Rodrigo Rota Bermejo.

PRODUCTION STAFF

Melina Bandeira (Editorial Coordinator); Teresa Borges and Eduarda Moura (Production Advisors); Maria João Pessoa Macedo and Patricia Werner (Graphic Design); Gabriela Costa (Proofreading); Elvyn Marshall (Translation); and www.shutterstock.com and FGV Projetos Image Bank (Photos).

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Luiz Inácio Lula da Silva
President of Federal Republic of Brazil
José Alencar Gomes da Silva
Vice-President of Federal Republic of Brazil

MINISTRY OF EXTERNAL RELATIONS
Ambassador Celso Amorim
Minister of External Relations
Ambassador Antonio de Aguiar Patriota
Secretary-General of External Relations
Ambassador André Mattoso Maia Amado
Sub-Secretary-General of Energy and High Technology
Minister André Corrêa do Lago
Director of the Department of Energy
Daniel Machado da Fonseca
Secretary of the Sub-Secretary-General of Energy And High Technology
Augusto Souto Pestana
Counselor of the Sub-Secretary-General of Energy And High Technology

EMBASSY OF BRAZIL IN DAKAR
Ambassadress Maria Elisa Teófilo de Luna
Ambassadress Katia Gilaberte

UNEP
Martina Otto
Head of the Energy and Transport Policy Unit
Cédric Essombe
Associate Programme Officer
Jérôme Malavelle
Administrator of the Bioenergy/Service Energy Program

EMBRAPA
Pedro Antonio Arraes Pereira
CEO
José Roberto Rodrigues Peres
CEO's Head Office
Esdras Sundfeld
Deputy Head of Research and Development
José Manuel Cabral S. Dias
Deputy Head of Communications and Business
Leovegildo Lopes de Matos
Regional Resident Representative – Africa Reginal Office

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Mamadou Falou Mbengue

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Cheikh Ibrahima Gaye
Djilbril D. Ka

STATISTICS, DEMOGRAPHIES AND SOCIAL (EDS)
Bakary Djiba

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Cheikh Wade
Amadou Sow

SENEGALESE INSTITUTE OF AGRICULTURAL RESEARCH (ISRA)
Macoumba Diouf

ENVIRONMENT AND DEVELOPMENT ACTION IN THE THIRD WORLD (ENDA)
Secou Sarr
Abdou Mdour

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