UNIVERSIDAD PONTIFICIA COMILLAS

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)

OFFICIAL MASTER'S DEGREE IN THE ELECTRIC POWER INDUSTRY

Master's Thesis

ECONOMIC EVALUATION OF PUBLIC INVESTMENT IN INFRASTRUCTURE PROJECTS IN WEST AFRICA: AN APPLICATION TO ENERGY AND TRANSPORT SECTOR

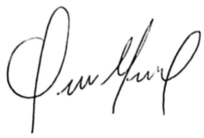
Author: Dessireé Menéndez
Supervisor: Sidy Diop
Co-Supervisor:

Madrid, July 2017

Master’s Thesis Presentation Authorization

THE STUDENT:

Dessireé Menéndez Archila



THE SUPERVISOR

Sidy Diop

Signed:  **Date: 05/ 07/ 2017**

THE CO-SUPERVISOR

Signed: …………………… Date: ……/ ……/ ……

Authorization of the Master’s Thesis Coordinator

Dr. Luis Olmos Camacho

Signed: …………………… Date: ……/ ……/ ……

UNIVERSIDAD PONTIFICIA COMILLAS

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)

OFFICIAL MASTER'S DEGREE IN THE
ELECTRIC POWER INDUSTRY

Master's Thesis

ECONOMIC EVALUATION OF PUBLIC INVESTMENT IN INFRASTRUCTURE PROJECTS IN WEST AFRICA: AN APPLICATION TO ENERGY AND TRANSPORT SECTOR

Author: Dessireé Menéndez
Supervisor: Sidy Diop
Co-Supervisor:

Madrid, July 2017

Master in Economics and Management of Network Industries (EMIN)

Abstract

ECONOMIC EVALUATION OF PUBLIC INVESTMENT IN INFRASTRUCTURE PROJECTS IN WEST AFRICA: AN APPLICATION TO ENERGY AND TRANSPORT SECTOR

Dessireé Menéndez

Africa is a region needed of high investment in infrastructure facilities to improve its living conditions and incentivize its economy. International institutions and governments are committed to develop infrastructure projects in different key sectors. However, the decision-making process could result in a difficult task when assigning scarce resources to extensive needs of the continent. Most infrastructure projects are implemented as public investment with different financial sources. Despite, the corresponding financial evaluation of the project, an economic approach has to be performed in order to measure the project's return for the society. Apart from this, it is important to develop an *ex post* economic evaluation as a tool for comparison purposes. The present study consists in the economic post evaluation of infrastructure projects in Senegal and Mali for the Islamic Development Bank (IsDB), develop with cost benefit analysis for three different projects within transport and electricity sector. Direct and indirect economic impact are identified and measure in monetary values. The obtained results are compared with the ex-ante evaluation and sensitivity analysis are performed for key variables.

Keywords: Economic evaluation, Cost-Benefit Analysis, Islamic Development Bank, Africa, infrastructure projects public investment.

Acknowledgments

First of all, I would like to dedicate this work to my daughter Adriana for being the reason to write these words, and the person who has unconditionally given me its support and time to finish my thesis. Adriana you are my motivation of living and I don´t have words to describe how much I love you, and how thankful I am of being able to share this experience with you by my side.

Also, a distinctive thank to Erasmus Mundus programme for the opportunity of continuing my studies abroad. To all Comillas and Paris Sud authorities for all its courses, support and follow-up along these two years and during the thesis elaboration. The master has overpassed my expectations in the academic, professional and personal experience.

I would like to personally thank my supervisor Sidy Diop for the trust, support and great opportunity of developing my thesis in Deloitte Economic Advisory. Also, a special recognition to IsDB and national authorities in Senegal and Mali for all their support in data gathering, doubts clarification and patience with my limitation with French language.

Finally, but not less important to my family for all its support and help during the process and having faith in my capabilities to make this dream come true. I don´t have words to express my gratitude to you.

I would end with a special mention to Nùria Roy, for being a motivation for me and my master´s friends, we were a group of five people starting this adventure, and we are finishing this journey all together. Nùria, you will always live in our hearts. Deniz, Isaac, Leandro and Alex you are a real family for us, I wouldn´t be able to do it without your friendship and support.

Content

List of Abbreviations

B/C	Benefits and costs
BCEAO	Central Bank of West African States in French
CAPEX	Capital expenditures
CBA	Cost Benefit Analysis
CENS	Cost of energy not served
CFAF	West African CFAF Franc
EDM	Mali´s National Electricity Company ("Eléctricité du Mali" by its name in French)
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
ENS	Energy not served
ESP	Emerging Senegal Plan
EUR	Euros
HFO	Heavy Fuel Oil
ICT	Information and Communications Technologies
MCFAF	Million West African CFA Franc
MEUR	Million euros
MTCO2	Metric ton CO2
MUSD	Million United States Dollars
O&M	Operation and Maintenance
OPEX	Operational expenditures
PCU	Passenger Car Unit
RI	Mali´s Interconnected System ("Réseau Interconnecté" in French)
SSA	Sub-Saharan Africa
UN	United Nations
USD	United States Dollars
VDN	Dakar Expressway (Voie de Dégagement Nord by its name in French)
VOCs	Vehicle Operating Costs
WAEMU	West African Economic and Monetary Union
WTA	Willingness to accept
WTP	Willingness to pay

List of Figures

List of Tables

1 Introduction

Economic evaluation is a fundamental tool for public investment infrastructure projects, as it provides an evaluation about the economic profitability (welfare gain for the society) for decision making of infrastructure projects implementation. "Cost Benefit Analysis" (CBA) is the method generally used to calculate the economic return of a project. CBA consists in comparing the benefits and costs of a project over a certain period.

Compared to the financial evaluation, used to analyse the net benefits from an investor´s point of view, economic CBA analysis also takes into consideration all direct costs and benefits of a particular project from a society´s point of view (Nickel, Ross & Rhodes, 2009). The methodology assigns monetary values to all benefits and costs, discounts them to a net present value and adds them into a single number to evaluate the project. (Jones, et al., 2014).

By comparing the economic values of various projects, CBA is an effective tool for development banks. It helps to allocate resources efficiently, allowing productive use of scarce financial resources. (Jones, et al., 2014)

This methodology was applied at zone-specific level by measuring the impact, mainly on local economy, for infrastructure projects financed by IsDB in Mali and Senegal. The evaluation of global impact at national level was not carry out due to the small project´s dimension and its limited contribution to overall economy.

Differences between *ex-ante* evaluation (realized during appraisal) and *ex-post* evaluation (conducted in this study) were also performed. The *ex* post evaluation results were compared with the initial evaluation to measure the changes in investment costs, implementation period, etc., and asses the profitability of each project. This exercise was done by the consultant only when data was available.

CBA was conducted by measuring the real return on investment of each project, measuring the direct and indirect impact on the local economy. The robustness of the results was also tested by performing sensitivity analysis to the discount rate and key variables for each project. The discount rate used in the analysis was the real discount rate calculated with the Government's Weighted Average Cost of Capital (WACC) for road and energy projects.

IsDB selected three different projects. Each project was treated individually according to its particular specifications and context. The selected projects are presented in the section 2.2.

1.1 Islamic Development Bank –IsDB-

Islamic Development Bank is an international Islamic financial institution, established in Saudi Arabia. Its purpose is to foster economic development and social progress of member countries and Muslim communities individually. The main functions are to participate in equity capital and grant loans for productive projects and provide financial assistance. It is also in charge with the responsibility of assisting in the promotion of foreign trade specially in capital goods. It is composed by 57 countries that are also part of the Organization of Islamic Cooperation (OIC).

IsDB financing concessions have grown proportionally with the increasing development needs of its members, since its inception in 70's decade, its net approvals went from USD 5.2 billion to USD 124.3 billion by the end of 2016. The radical increase was due mainly to the scale up of its operations to help member countries cope with the effect of global financial turbulences.

Aid's allocation among the different countries was distributed as follows: USD 48.2 billion granted to Middle East and North Africa (MENA), followed by Asia and Latin America (ALA) with USD 36 billion, then USD 22 billion for Sub-Saharan Africa (SSA) and finally, USD 17.7 billion for Europe and Central Asia (ECA). Most of the financing approvals were oriented in transport sector for SSA and in energy sector for MENA region. (IsDB, 2017)

1.2 Projects selection

IsDB project's selection to perform the economic post-evaluation, were focus on various industries in SSA with different financing participation from the bank. The table below introduces the specifications of each project with their corresponding location, industry, IsDB's finance participation, approved and completion date.

Table 1 Selected projects for ex-post evaluation

No.	Projects	Country	Industry	Amount (MUSD)	Approved date	Completed date
1.	Power Generation Expansion (MLI0092)	Mali	Energy	69.55	2007	2014
2.	Construction of Saraya-Kita Regional Road Project in Senegal and Mali (MLI0079 and SE 0080)	Senegal-Mali (Regional project)	Transport	9.45	2003	2009
3.	Upgrading of Dakar Expressway (SEN0096)	Senegal	Transport	39.39	2006	2011

Source: IsDB, 2016

1.3 Country's overview

1.3.1 Senegal

Senegal is located in West Africa with a national territory of 196 722 km^2. The country enjoys a favourable geographic location, with a major seaport and easy access to European and North American markets. Senegal has maintained a stable macroeconomic environment in recent years. The country is a member of the West African Economic Monetary Union (WAEMU), an eight countries[1] customs and currency union in which all members use the CFA franc (CFAF)[2]. The economic union has a market of 112 million consumers[3]. It is based on the free movement of persons and goods, a common trade

[1] Besides Senegal, WAEMU also includes Benin, Burkina Faso, Cote d'Ivoire, Guinea Bissau, Mali, Niger and Togo.
[2] The CFAF is the common currency of West African Economic and Monetary Union (WAEMU). It is an eight-country customs and currency union in which all members use the CFAF. The Union members includes Benin, Burkina Faso, Côte d'Ivoire, Guinea Bissau, Mali, Niger, Senegal, and Togo amounting 112 million inhabitants. The banking sector of member countries is regulated by the Central Bank of West African States (BCEAO by its name in French) which also maintains a fixed exchange rate with the euro.
[3] http://www.uemoa.int

policy with a common external tariff (CET), and a regional financial market with a regional securities stock market (the Western Africa Regional Stock Exchange or BRVM).

Banking sector of WAEMU region is regulated by the Central Bank of West African States (BCEAO) which also maintains a fixed exchange rate with the Euro (EUR). Senegal is also a member of the Economic Community of West African States (ECOWAS) made up of 15 countries[4] which promotes economic integration and regional peace and stability, 358.6 million of inhabitants were located in the ECOWAS region in 2016[5]

Senegal's mostly young population is estimated at 15.3 million in 2016.[6] 23% of the population lives in the greater Dakar region (which makes up 0.3% of the territory), and 40% lives in other urban zones. People under the age of 24 represent more than 60% of the population.

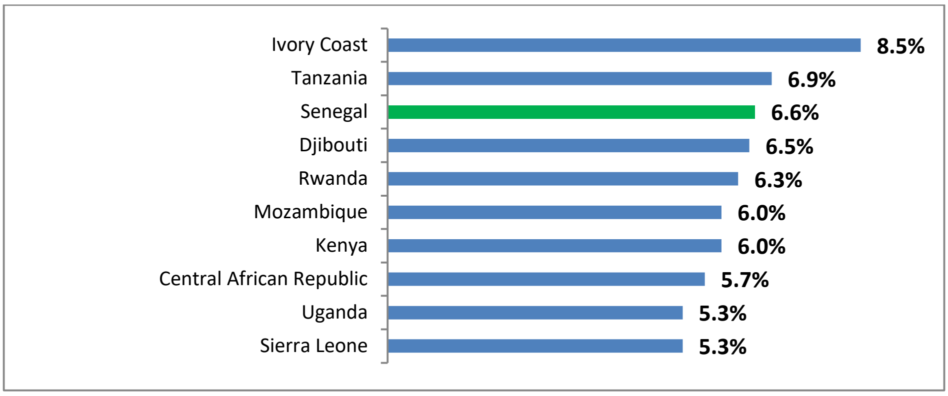
Economic context

Senegal has the fourth largest economy in the West African sub-region after Nigeria, Ghana and Côte d'Ivoire. The country is the second largest economy in Francophone West Africa behind Côte d'Ivoire, with an average growth rate of 5.39% during the five past years. It is an open economy with major trade flows with Europe and India. Its main economic partners are France, India, Italy, China and United States (US).

According to the World Economic Forum (WEF), with a GDP growth rate of 6.6% in 2016, Senegal was among the top three fastest growing economies in Africa, behind Côte d'Ivoire and Tanzania.

[4] ECOWAS includes the eight countries of WAEMU plus Cap Verde, the Gambia, Ghana, Guinea, Liberia, and Sierra Leone.
[5] World Bank, 2016
[6] World Bank, 2016

Figure 1 Africa's 10 fastest-growing economies, 2016



Source: Word Economic Forum (WEF), 2016

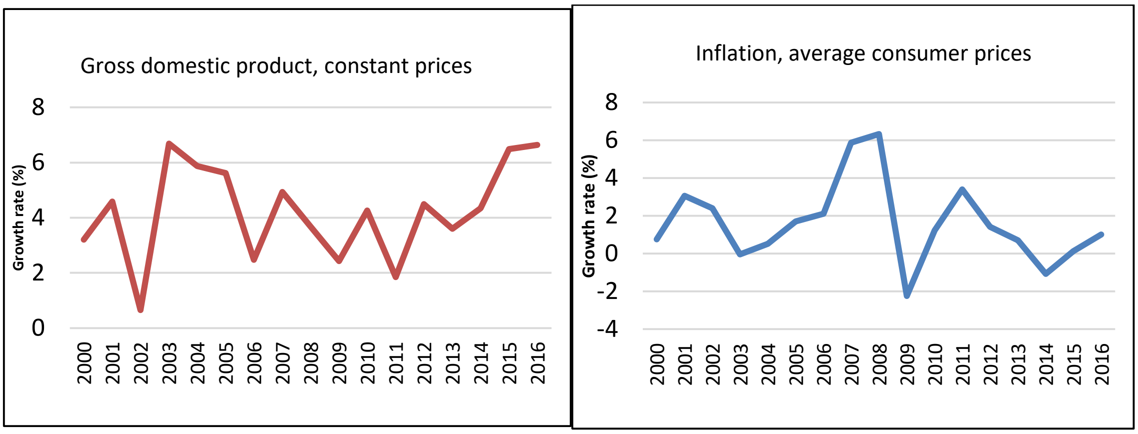
Since 1994, the country has adopted a radical economic reform programme in accordance with the international donor community's directive in order to strengthen its macroeconomic fundamentals. This reform coincided with the devaluation of Senegal's currency, the CFAF which was pegged to the former French Franc at a fixed rate. After the reform programme, Senegal enjoyed a GDP growth rate of around 5% per year over the 1995-2002 period. Inflation stabilised during the 1990s. (Deloitte, 2017)

To drive national development objectives, the government privatised companies involved in airline, water, finance, Real Estate and telecommunications sectors with no restriction on the participation of foreign investors. Several state-owned firms were sold fully or partially to foreign entities. In the energy sector, the state-owned electricity company, Senelec, operates transmission and distribution networks while the government has encouraged private participation in electricity generation under power purchase agreements. (Deloitte, 2017)

The government is still involved in ports and infrastructure projects but granted a private concession for container ports. It also resorted to a public-private partnership (PPP) to complete a toll road connecting the Dakar peninsula with interior roads. Telecommunications, commerce and tourism also grew strongly since the government's liberalisation measures. (Deloitte, 2017)

Senegal's macroeconomic performance has been strong in recent years. Real GDP more than doubled (increase of 108%) between 2000-2016, driven mainly by telecommunication and financial services, which accounted for 70% of economic growth. In 2016 the growth rate was estimated at 6.6%, and was described by the World Bank as "remarkable". (Deloitte, 2017)

Figure 2 Senegal's macroeconomic performance (%) 2000-2016



Source: IMF database, 2016

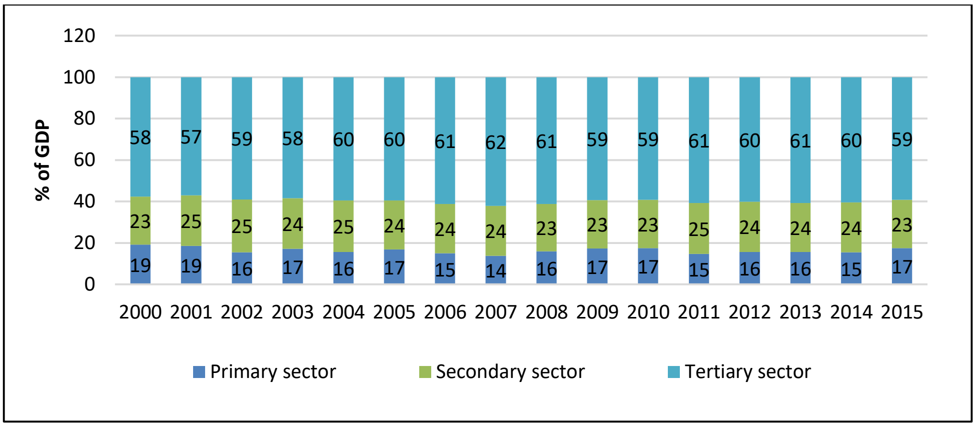
Senegal has a low inflation rate, with an average rate of 1.6% from 2000 until 2016. In 2008, it reached an all-time high of 5.85%. The main reason was the sharp rise in product prices, in particular food and energy products used by households.

Senegal's monetary policy remains in line with the objectives of economic stability and growth. It is defined by BCEAO with the aim of reducing inflation and preserving a fixed exchange rate between the CFAF and the EUR.

Sector contribution to GDP

In figure 3, the sectoral decomposition of the added value (% of GDP) of the economy, shows the predominance of tertiary sector. Services sector accounted for nearly 60% of total value added between 2000 and 2015. The primary sector for 16% of GDP over the same period. The weight of the secondary sector in value added was consistent from 2000 to 2015, at around 23%.

Figure 3 Sectors value added (% of GDP), 2000-2015



Source: The World Bank database, 2016

Senegal has grown to a similar pace as population pace, provoking an insufficient economic performance against poverty, especially in rural areas. From this, it was necessary to create a break with the past economic behavior of the country, to raise, sustainably, its growth potential and stimulate the private sector to satisfy all population needs.

During the period from 2005 to 2015, the average GDP growth rate was 4%, while population rate grown at a pace of 3%, what reflects a structural break between both indicators that will provide better economic and living conditions in the country.

The Emerging Senegal Plan 2014-2018 (ESP) was developed to adopt a new model focus on accelerating the progress towards emergence in the country. It establishes the framework for the country´s economic and social policy over the medium and long term. The main objectives are to obtain a GDP growth rate of 7-8%, create 600,000 formal jobs and reach a GDP per capita of $1,500.00. According to ESP plan, an annual growth rate of 7.1%, on average, will be achieved. Current indicators already showed that, for 2014 and 2015 the GDP growth reached values of 4.3% and 6.5% approximately. (Deloitte, 2017)

Transport sector

Senegal places transport at the core of its development strategies, with the formulation of sector policies underpinned by substantial investments in infrastructure and services. Despite increased funding for physical infrastructure, the high cost and low quality of road and rail infrastructure continue to be a major obstacle to improve the competitiveness of the economy. The sector still needs to deal with the limited and unevenly distributed national road network, the inadequate supply of urban public transport services, as well as an ageing vehicle fleet and rail and port infrastructure. (African Development Fund , 2014)

To meet these challenges, the State has developed several transport sector policies (PST1, PST2). The Government of Senegal, in its New Transport Sector Policy Letter (LPST3 2010-2015) has adopted a programme consisting in carrying out major works and core projects that will help to develop and modernise the country's transport infrastructure. The LPST3 objectives have social and economic goals. At economic level, wealth creation is sought through least cost access to national and international markets (improvement of existing corridors, opening of new corridors, and support for other productive sectors). At social level, the objective is to ensure equal wealth distribution by developing domestic road networks to meet the demand of urban and rural populations in terms of accessibility and mobility and foster inclusive growth. The strategic thrusts of LPST3 are: 1) internal and external access facilities for the country; 2) better performance of transport services; and 3) sustainable mobility of goods and people. (African Development Fund , 2014)

1.3.2 Mali

Mali is a vast country located in West Africa with a total land area of 1,240,278 sq. km of which 60% is desert. It is sparsely populated with 17.6 million inhabitants in 2015[7]. Mali is a landlocked country with a total land boundaries of 7,243 km with the following countries: Algeria 1,376 km, Burkina Faso 1,000 km, Guinea 858 km, Côte d'Ivoire 532 km, Mauritania 2,237 km, Niger 821 km and Senegal 419 km.

The Malian economy is dominated by agriculture, livestock husbandry and other primary sector activities which together account for about 50% of GDP. The main agricultural production takes place in the fertile south what makes it a vulnerable economy to commodity price fluctuations and to the consequences of climate change. Cotton is one of the main export products positioning as the leading cotton producer in Sub-Saharan Africa (SSA).

10% of its population lives in the northern region. High population growth rates and drought have fuelled food insecurity, poverty, and instability. The delivery of services in this large, sparsely populated territory is challenging, and affects geographic equity and social cohesion. Population growth (3.6%) remains high but the government has pledged, through its national urban policy, to improve the life of urban dwellers, boost local economies, tackle under-unemployment and poverty, support socio-cultural diversity and strengthen local civic rights.

Economic activity slowed in 2015, with real GDP increasing an 5.2% in 2015 (5.8% in 2014), due to poor agricultural sector performance. The secondary sector fared badly too, with growth of 2.6% in 2015 (9.2% in 2014). In agro-industry, overwhelmingly plant-oil mills growth fell to 18% (down from 35% in 2014) because of poor agricultural output, especially cotton. Contrary, growth strengthened in the tertiary (services) sector, at 6.9% (up from 3.6% in 2014). The current account deficit (including grants) improved to 3.6% of GDP (from 5.7% in 2014) due to lower oil prices and more volume exports of gold,

[7] (World Bank, 2017)

improving the terms of trade to 15.2% (from 5.3% in 2014). The current account deficit is expected to be entirely funded by foreign direct investment (FDI) in gold and telecommunications followed by foreign loans. (AFD, 2016)

Medium-term macroeconomic prospects are acceptable, with overall growth forecast at 5.2% in 2016 and 5.0% in 2017, driven partly by more public investment and foreign aid and by the agricultural and service sectors. But the current account (including grants) deficit is expected to widen to 4.1% of GDP in 2016 and 5.2% in 2017 due to lower gold production and poorer terms of trade. The deficit should also be funded by FDI (gold and telecommunications) and foreign loans. The good prospects could be undermined by continuing risks such as the security situation, unpredictable gold and cotton prices and bad rainfall. (AFD, 2016)

Mali has made progress in recent years towards the Millennium Development Goals (MDG) of universal primary education (Goal 2), combating HIV/AIDS (Goal 6) and access to safe drinking water (Goal 7, target 10). The security crisis has set back this progress but it should be strengthened with implementation of the 2015-2030 United Nations (UN) Sustainable Development Goals that the country has also signed up to. (AFD, 2016)

With the progressive consolidation of political stability and improved security conditions, growth accelerated to 7.0% in 2014, its highest level since 2003, and remained robust in 2015 and 2016 at 6.0% and 5.4%, respectively. Mali's economy is projected to grow by around 5% over the period 2017-2019, reflecting a return to normal conditions and a gradual tapering of the recent surge in international aid.

All economic sectors are expected to contribute to growth in 2017 according to (World Bank, 2017), especially the tertiary sector, which is projected to grow faster, in reaction to the continued dynamism of telecommunications and transport.

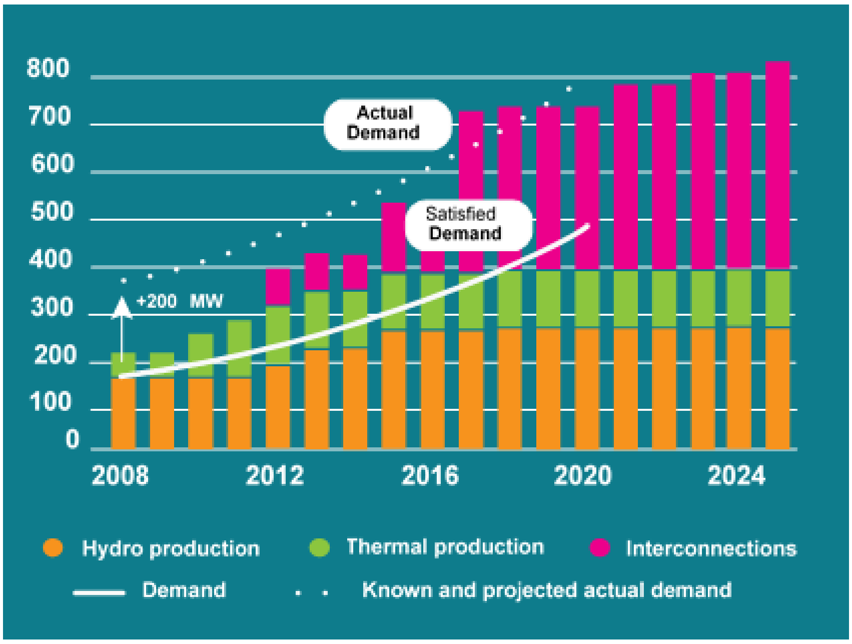
Energy sector

The primary energy supply in Mali is biomass, supplying 78% of all energy consumed. Electricity access rates are low but improving, at 55% in urban and 15% in rural areas. Electricity demand is growing extremely fast (about 10% per year in recent years) driven by domestic consumers and the industrial and mining sectors. The national grid has a large but declining share of hydro power generation, but isolated centres and large captive generators still rely exclusively on fossil fuels to satisfy their energy needs. Despite the dependence on fossil fuels, international electricity trade will have a growing role in the next years. In rural areas, a decentralised approach is being pursued due to lack of interconnection network, allowing private energy services companies to operate.

Electricity Sector

Electricity sales from the national electricity company -"Electricité de Mali" by its name in French- (EDM) [8], increased consistently in recent years, surpassing 1,000 GWh in 2012 from 785 GWh in 2008 and averaging 6.6% growth per year. The number of clients also increased from 202,000 to 290,000 during the same period.

Figure 4 On grid energy demand and production projections in power (MW)



Source: (AFD, 2015)

Unfortunately, the country presents an unexpressed and largely unsatisfied demand for electricity, both for domestic users and for large industrial complexes, in particular in the mining sector. In 2012, the installed base reached 357 MW for the central grid and 68 MW for isolated centres[9]. Industries and mines, on the other hand, have an estimated installed base of 200 MW to satisfy their own demand. The mining sector alone experienced significant growth passing from 47 MW to 136 MW

[8] EDM is the national electricity company in Mali part of "Energie de Mali" corporation in charge of electricity generation in the country.
[9] Source EDM-SA - http://www.edm-sa.com.ml/edmsa/chiffres.asp

between 2008 and 2011, exclusively from thermal power plants. The lack of reliable, lower-cost grid electricity is considered a barrier for further development of the sector.

In 2013, the capacity gap to meet demand was estimated at 111 MW. In 2014, estimated capacity gap experienced a reduction reaching a value of 32 MW.

Increase in demand presents a significant challenge for the sector. The Government's energy access program involves expansion of both grid and off-grid renewable and non-renewable energy sources. Moreover, increased regional integration could help Mali meet its energy needs through electricity imports.

The Malian electricity sector can be divided into four segments: the interconnected system, isolated centres, captive generation by large consumers and the rural sector. The interconnected system (RI by its name in French), owned and managed by EDM, is dominated by hydroelectricity, mainly generated by the Manantali Dam (of which Mali owns 104 MW out of the total 200 MW) and Sélingué (46 MW). Hydroelectricity represented 60% of all electricity produced in 2012, while the rest was generated by diesel or heavy fuel power stations. Notably, in recent years, the Manantali Dam encountered production problems and other important hydro plants (Sélingué and Sotuba) are experiencing delays in their 10-year maintenance schedules. Therefore, the share of hydroelectricity in the RI decreased to 44% in 2014 (Table 2).

In 2013, the generation profile of EDM was as follows: 21% of energy delivered was thermal, generated by EDM; 26% was purchased thermal generation; 16% was hydro, generated by EDM; and, 37% was purchased hydroelectricity. The share of thermal energy in the energy mix is expected to increase, between 2014 and 2017, to 62% (Table 2).

Table 2 Mali Electricity Mix, interconnected system, including imports.

	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Real	Real	Plan	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Thermal	39.9%	47.0%	55.7%	59.9%	60.6%	61.9%	50.7%	51.2%	55.2%
Hydro	60%	53.0%	44.2%	39.9%	36.3%	35.3%	46.9%	44.5%	40.9%
Solar	0%	0.0%	0.1%	0.2%	3.1%	2.8%	2.4%	4.3%	3.9%
GWH	1275	1402	1629	1789	1966	2197	2516	2741	2985

Source: Mali - 2014 Provisional Electricity Recovery Plan

To keep up with demand, EDM invested in two medium-sized thermal generation projects (heavy fuel oil plants) inaugurated in 2010 for a total of 90 MW. The Malian grid is already regionally interconnected to Mauritania, Senegal and Cote d'Ivoire. Further reinforcement of the connection is planned to lower the cost of power in the medium term, allowing Mali to purchase more power from its neighbours.

There are few experiences with renewable energy on EDM grid, namely hybrid power plants (diesel/photovoltaic solar). The first was inaugurated in February 2011 (216 KWp[10]) and two others in 2014. Solar production is expected to ramp up and account for around 4% of total energy generated by 2020.

EDM also serves 22 isolated centres exclusively with diesel power plants, for a total of 68 MW as of 2012 (Table 3).

Table 3 EDM SA Installed Base, 2008-2012.

EDM	Unit	2008	2009	2010	2011	2012
Interconnected Grid	MW	243.3	253.3	273.3	327.3	357.3
Isolated Centres	MW	49.7	57.2	60.1	67.4	67.9
Total	MW	293.0	310.5	333.4	394.7	425.2

Source: EDM, 2015

Large consumers in the mining and industrial sector also exclusively use thermal generation to satisfy their needs (200 MW) whereas rural electrification uses a mix of diesel and PV.

The volume of EDM's fuel consumption tripled from 2005 to 2010[11]. In 2010, the electricity sector of Mali was around 50% dependant on fossil fuels; this share is believed to have further increased since then. If private captive generation[12] is included, the Mali energy system has a clear prevalence of fossil fuel generation. The economic growth experienced by the country in the first decade of the century

[10] Peak power. The value specifies the output power achieved by a solar module under full solar radiation.
[11] EDM - Plan de Redressement de la Situation Financiere et Operationelle du Secteur de l'Electricité, March 2014.
[12] Captive generation are auto-producers, used for self-consumption in the industry sector.

required a rapid increase of energy generation achieved through new thermal power plants[13]. With a view to enhancing energy security, Mali´s government is keen to reduce fossil fuel imports and embark on a low carbon emission development path for both grid and off-grid electrification schemes. (AFD, 2015)

Electricity generation is vulnerable to climate variability since a significant portion of the on-grid supply managed by EDM comes from hydro power plants. It is worth noting, however, that water system is made up of two large rivers, namely the Niger and Senegal, forming immense watersheds (300,000 km^2 for the Niger, and 155,000 km^2 for the Senegal). The total flow potential of these two river systems is estimated at 56 billion m^3 per year, and the country's estimated hydro potential is, as of 2014, nearly 1 GW. (AFD, 2015)

Transport sector

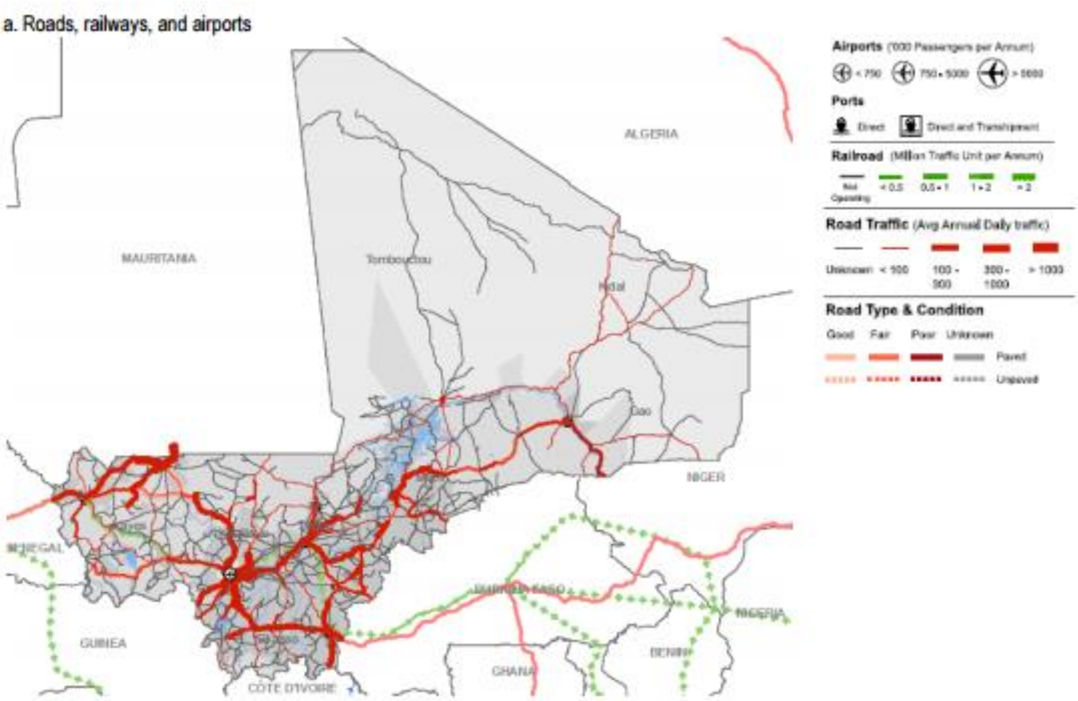
The distribution of Mali's infrastructure network reflects the population spreading and has a strategic focus on integrating the country with regional networks and export points. As a result, the density of transport, power, and ICT[14] infrastructure is greater in the south than in the north. Mali has one of most spatially concentrated infrastructure networks in the continent. With the exception of some roads that connect scattered mining sites and irrigation areas, Mali's northern region is an inaccessible desert. Mali depends heavily on regional corridors and regional infrastructure, particularly for transport and water resource development. Currently, three international trade corridors (Tema–Ouagadougou– Bamako, Dakar–Bamako, and Abidjan–Ferkesessedougou–Bamako) link Mali to the sea. Due to the security situation in Côte d'Ivoire some years ago, which traditionally provided Mali with access to the sea, transit patterns have shifted to other corridors and associated ports in the sub region like Dakar in Senegal. Mali is also part of the Transahelian road corridor (Nouakchott–Ndjamena), which is expected to gain relevance for intraregional trade in the ECOWAS region. The rail network of the region is essentially disconnected. Rail networks use three different gauges, which makes regional rail interconnection difficult and reinforces the importance of road corridors. However, there is already a proposal to connect Transrail (the Mali-Senegal rail company) with Sitarail (the Côte

[13] Recent thermal plants include, notably, the Kayes and Kita plants in 2002, CAT (2, 4, 6) in 2006, the Balingué Plant (Indian generators) in 2007, and the BID and SOPAM plants in 2010. A portion of the thermal energy has also been imported from Nouakchott (AGGREKO) since 2007.

[14] Information and Communications Technologies

d'Ivoire-Burkina Faso company). Below it is shown the map of roads, railways and airports for the country. (AICD, 2011)

Figure 5 Transport infrastructure in Mali



Source: (AICD, 2011)

2 Literature Review

Network industries are characterised for being long lasting industries with capital intensive needs. Building infrastructure projects demands high financing funds from different sources and detailed evaluation techniques oriented to assure the profitability of the project.

The profitability of the project can be measure from different perspectives. A financial perspective that is oriented in the investor's return considering key variables like interest rate, amortization technique, etc. However, according to (European Investment Bank, 2013) markets are not always sufficiently competitive, prices are distorted and property rights are not well defined. In the same line, (Asian Development Bank, 2013) arguments that key outputs from many projects are either not sold on a market like non-toll roads, solid waste management, reduction in air and water pollution, health improvements, among others; or are sold in distorted and/or controlled markets like water and electricity sales subject to administrative pricing. Furthermore, the project can be evaluated under an economic perspective oriented to obtain the real economic return of it for the society. Benefits in terms of social welfare improvements differ from project revenues obtain from financial appraisal.

A potential drawback and limitation of economic evaluation is the fact that different kinds of variables could be taken into consideration, where some of them are not always easily quantifiable.

As stated by (European Investment Bank, 2013), the standard economic appraisal technique, which helps assessing the socio-economic desirability of the project, is CBA. It is designed to produce a measure of project returns corrected for market's distortions and constraints. CBA has a long tradition worldwide and its origin, as a discipline, is attributed to a French engineer, Jules Dupuit (1848), before being implemented by economists.

According to (Rus, 2016), CBA is largely the quantification in monetary terms of the incremental changes, as derived from the implementation of a transport project, in individuals´ surplus with respect to a counterfactual.

Other economic appraisal techniques might be applied. Depending on the nature of the alternatives to be assessed, and the type of data available, a comprehensive CBA may not be possible. In such cases, the methodology could be replaced by a cost-effectiveness analysis (CEA, focusing on the cost of attaining a given target) or multi-criteria analysis (MCA). These alternatives are not necessarily substitutes for each other and may well be seen as complementary to full CBA, particularly if economic viability is to be weighed with other policy considerations. (European Investment Bank, 2013)

(Garber & Phelps, 1997) arguments that CEA analysis (applied to health sector) describes an intervention in terms of the ratio of incremental costs per unit of incremental health effect (i.e., marginal cost/marginal health effect), providing a useful tool for evaluation when the target is already defined without the mandatory need of assigning a monetary value to all benefits and costs.

When considering MCA (Department for Communities and Local Government: London, 2009) establishes preferences between options referring to an explicit set of objectives that the decision making body has identified.

CBA also presents limitations that are appointed by (Quinet, 2013), (Asian Development Bank, 2013) and many other authors. First, for its inaccuracy in terms of monetising all benefits and costs, then for not being able to reflect explicitly government´s preferences for decision making in public investment, among others. From this, it is recommendable to complement the methodology with other techniques like CEA and MCA in order to obtain a more robust analysis.

2.1 Social discount rate

The choice of the correct discount rate is still a not defined issue subject to a wide debate mainly due to the ethic component behind it. (Stern 2006) released an environmental document titled, "The Economics of Climate Change" where the author issues a warning that failing to invest 1% of GDP today to reduce global warning could risk a future reduction of 20%, where the social discount rate is playing an important role of defining the viability of investing in this 1% of GDP.

(Zhuang, et al., 2007) defines the social discount rate as the rate that reflects a society's relative valuation on today's well-being in the future having important implications for resource allocations.

As mentioned before all costs and benefits in CBA are expressed in monetary terms for each year of the project's lifetime. These values are discounted to obtain their present value by using the social discount rate. Future benefits (or costs) are less valued than current ones. The four following approaches can be used to estimate the social discount rate:

1. Weighted average cost of capital (WACC): calculated specifically for the type of project and country considering its debt and equity components.
2. Social rate of time preference (SRTP): Rate at which the society is willing to postpone a unit of current consumption in exchange for more future consumption.
3. Marginal social opportunity cost of capital (SOC): based on the argument that resources in any economy are scarce, and that the government and private sector compete for the same pool of funds. Therefore, public investment should yield at least the same return as a private investment. This rate can be calculated with the pre-tax rate of return.
4. Weighted average approach: It is based on the reconciliation between the SRTP and SOC with the argument that public investment displaces private investment but not private consumption. (Zhuang, et al., 2007)

Public investment in many countries in the world have adopted different methodologies for social discount rate calculation having various levels of discount rate depending on sector, size or characteristics of the project. Social discount rates with its corresponding methodology are shown below in table 4:

Table 4 Discount rate methodology for different countries in the world

Country	Discount rate	Theoretical basis
France	Real discount rate 4% in 2005	SRTP approach
India	12%	SOC approach
China	8% for short and medium term projects; lower than 8% for long-term projects	WACC
US (Congressional Budget Office and General Accounting Office)	Rate of marketable Treasury debt with maturity comparable to project span	SRTP approach

Source: (Zhuang, et al., 2007)

3 Methodology

The main results CBA under an economic approach are:

1) Economic Net Present Value (ENPV) and 2) Economic Internal Rate of Return (EIRR) were used as a first approach to evaluate each of project. They are defined as the following:

$$ENPV = \frac{B_0 - C_0}{(1+i)^0} + \frac{B_1 - C_1}{(1+i)^1} + \cdots + \frac{B_T - C_T}{(1+i)^T}$$

$$0 = \left[\frac{B_0 - C_0}{(1+EIRR)^0} + \cdots + \frac{B_T - C_T}{(1+EIRR)^T}\right]$$

Where,

B = Benefits

C = Cost

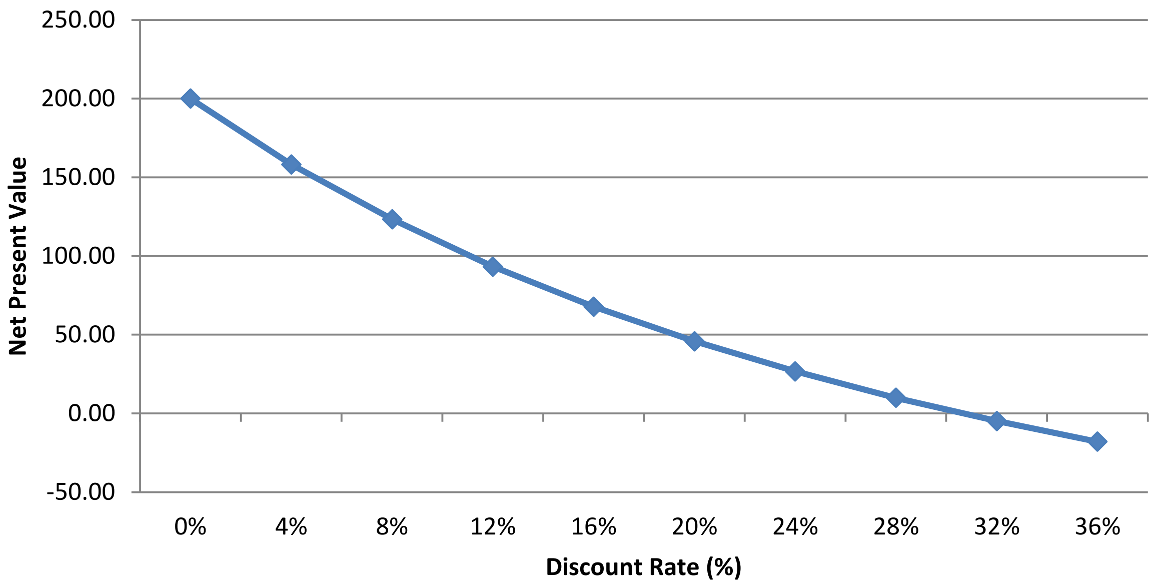
i = discount rate of the project

T = Time period/Life duration of the project

EIRR = Economic internal rate of return at which the NPV equals 0. (ADB, 2014)

As mentioned in section 1, due to the sensitivity of discount rate for long-term projects, sensitivity analysis was implemented to measure the impact of changes in discount rate in ENPV or benefits/cost ratio.

Figure 6 Sensitivity Analysis of Economic Net Present Value ENPV



The relationship between discount rate and ENPV is inversely proportional, with decreasing marginal returns when the discount rate reaches higher levels. For small values of discount rate, the ENPV is highly sensitive to variations in the discount rate, whereas for higher values the impact is smaller. Previous asseveration will be tested in the present study.

3.1 Basic assumptions

Taxes are omitted considering they are not a fixed cost of the project, but a transfer of money from one sector to the other. A cost for one sector is seen as a benefit for the other one. (European Investment Bank, 2013)

In order to measure the value of a project, two scenarios were built: “with” and “without” the project.

The evaluation period corresponds to the lifetime of the infrastructure according to the documentation provided by IsDB.

Environmental impact of all types of infrastructure projects was limited to CO2 emissions for simplicity purposes and missing data for other types of atmospheric pollutants.

Computations were done in CFAF, considering that it is the local currency for both countries and most benefits and costs are settled in CFAF. However, results are presented in euros (EUR) and U.S. American dollars (USD)[15]

Job creation during construction period was not taken into consideration to avoid double counting problem. (CEEU, 2012)

Residuals values of the project were not calculated, assuming that the residual value of all projects will be zero at the end of its useful life.

Benefits were separated between direct ones, which consist of all the benefits directly related to the project´s production or its use, and indirect benefits that are all other economic activities generating an overall economic impact not directly related to the project´s core.

The analysis was developed in real terms (constant prices), without considering the inflation during the project's lifetime.

The social discount rate was calculated with the Fisher´s equation[16] from the government´s WACC for each project and the average inflation rate for the period 2000-2015 for each country.

3.2 Benefits monetisation

3.2.1 Benefits calculation of Road Projects

The economic evaluation of road projects consists of the following three main components:

- identify the project scope and description
- quantify the economic costs of building and maintaining the infrastructure
- determine the associated benefits of this infrastructure over time

More precisely, the evaluation is performed with the following structure:

[15] (Damodaran, s.f.)
[16] (1 + nominal rate) = (1 + real rate) x (1 + inflation rate) taken from (Investopedia , 2017)

- ✓ Time savings
- ✓ Vehicle operating cost savings

Measured at individual level

- ✓ Improving transport safety and reduction in accidents[17]
- ✓ Pollution

Measured at collective level

If the new road replaces the existing road (e.g. in case of upgrading or reconstruction), then all previous users are assumed to be users of the new road.

Generally, the typical average economic life considered for investments of this type is 30 years, however the economic life considered was in function of the information provided by the bank. (NSW Government, 2013).

Traffic

The analysis also consisted in forecasting traffic, in terms of existing traffic growth and in term of traffic either diverted from other connecting roads or generated by new economic activities.

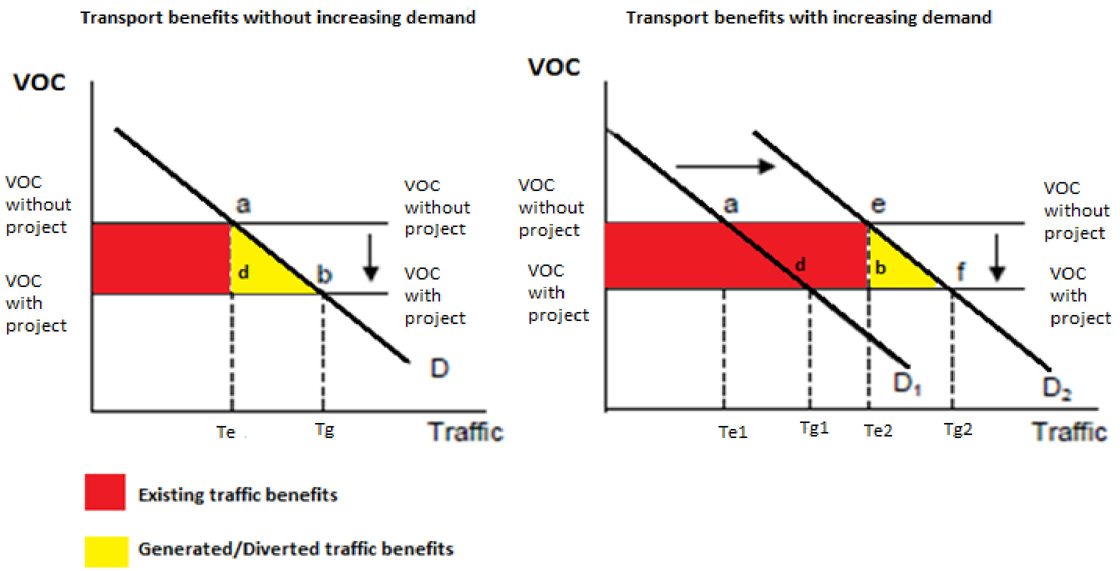
Traffic is classified between existing and generated/deviated one, where the benefits of the last one is less valuable. This principle is based on economic theory as the willingness to pay (WTP) for the project is lower for new users, with alternative ways of transportation, than existing users who are obliged to make use of the existing road conditions.

The principle of traffic classification applies to VOC and time savings[18]. Road projects can generate two different effects in the traffic demand curve. The first effect is an increase in current demand (along the demand curve without project) due to the reduction in VOC or time. Whereas the second effect, is a shift in demand due to a positive shock that incentivize additional users to make use of the improved road.

Therefore, benefits from existing traffic are valued at 100% (red area from figure 7), and generated/diverted traffic are valued at 50% (yellow area from figure 7). (European Investment Bank, 2013)

[17] In the same line, accidents can be more numerous or deadlier with a new road allowing faster rides, etc.
[18] Detail calculation of both economic benefits in Table 5.

Figure 7 Impact in traffic demand due to changes in VOC in road projects



For road infrastructure projects, the methodology considers four direct benefits: 1) Vehicle Operating Costs savings, 2) Time savings, 3) Accident cost savings, 4) Road maintenance cost savings.

Three indirect benefits are considered: 1) Environmental impact, 2) Job creation during implementation period; and, 3) Increase in local earning due to new businesses or infrastructure.

Table 5 Benefits calculation of Road Projects

Direct Benefits	Description	Economic Evaluation
1.Total vehicle operating costs savings (VOCs)	Evaluated by the number of kilometers travelled for all traffic recorded and estimated, quantifiable in terms of lower fuel and lubricants consumption, operation and maintenance (O&M) cost, insurance, etc. VOCs are correlated with the type of vehicle, the average travel speed, and the roads specific characteristics such as design standards. (European Commission, 2014)	**For existing traffic:** $$VOCSe = \sum_{y=1}^{n} (VOC_{fv} - VOC_{ov}) * t_e * d$$ Where, VOC_{fv} = Vehicle Operating Cost with the project per vehicle. CFAF/km. VOC_{ov} = Vehicle Operating Cost without the project per vehicle. CFAF/km. t_e = Existing recorded and forecasted traffic in number of vehi VOCSe= Vehicle Operating Cost savings for existing traffic. d = Number of km of the road. y = evaluation years of life duration of the project. **For generated/existing traffic:** $$VOCSg = \sum_{y=1}^{n} \frac{1}{2}(VOC_{fv} - VOC_{ov}) * t_g * d$$ Where, VOC_{fv} = Vehicle Operating Cost with the project per vehicle. CFAF/km. VOC_{ov} = Vehicle Operating Cost without the project per vehicle. CFAF/km. t_e = Existing recorded and forecasted traffic in number of vehi VOCSg= Vehicle Operating Cost savings for generated/diverted traffic. d = Number of km of the road. y = evaluation years of life duration of the project. And, $$VOC_{fv} = AVG(f_t) + AVG(l_t) + AVG(m_t)$$ Where, f_t = Fuel consumption cost per type of vehicle in CFAF/km with the project. l_t = Total lubricants consumption cost with the project. m_t = average maintenance cost per type of vehicle with project, in function of labor force and repair parts. $$VOC_{ov} = AVG(f_o) + AVG(l_o) + AVG(m_o)$$ Where, f_o = Fuel consumption cost per type of vehicle in CFAF/km without the project. l_o = Total lubricants consumption cost without the project. m_o = average maintenance cost per type of vehicle without project, in function of labor force and repair parts.

2.Total value of time savings (T_s)	Measure by the economic value of time savings as a function of the average economic income of users. (European Commission, 1997) Time savings are classified between existing and generated/diverted traffic considering the WTP of both types of users is different (existing traffic is willing to pay more for the project than generated/diverted one as its opportunity cost is lower)[19]: -Time savings benefits for existing traffic (Te): Traffic that was already using the road. - Time savings benefits for generated/diverted traffic (Tg): Traffic diverted from other transportation modes like other roads or railways. It is value at half of existing traffic. (European Commission, 2014)	$$T_s = \sum_{y=1}^{n}(Tev + Tgv)$$ Where, Ts = Value of time savings Te = Value of time savings for existing traffic. Tg = Value of time savings for generated traffic. n = Number of years during lifetime of the project. v = Type of vehicle. $$T_e = [(tf_v - to_v)x\ O_v]x\ w$$ Where, to_v = Travel time without the project tf_v = Tavel time with the project w = Average income per habitant o = Occupancy rate per type of vehicle. v = Type of vehicle. $$T_g = \frac{1}{2}[(tf_v - to_v)x\ O_v]x\ w$$ Where, to_v = Travel time without the project tf_v = Tavel time with the project w = Average income per habitant o = Occupancy rate v = Type of vehicle.

[19] See traffic section for more clarification.

3.Total value of reducing the number of accidents. (ACS) 1. **Value of reduction in Non-fatal accidents (A_N), which can be classified in severe (S_{AN}) and slight injuries (L_{AN})** 2. **Value of reduction in fatal accidents (A_F)** **Accidents are composed by two types of cost:** **Direct costs: All directly related costs like medical rehabilitation, administrative, court, insurances, etc.** **Indirect costs: consist of the net production loss to society.**	Evaluation of direct costs: 1. Fatal accidents: All directly related costs like material losses, medical rehabilitation of third parties, administrative, court, insurances, etc.[20] 2. Non-fatal accidents: total cost of hospital treatment and cost of income lost due to possible absence from work or at 15 % and 18 % of VOSL production losses for, respectively, severe and slight injuries. (European Commission, 2014) Evaluation of indirect costs: 1. Fatal accidents: value of human life quantified on the basis of average income and life expectancy. (European Commission, 1997) It is preferable to use stated preference or revealed preference techniques based on the concepts of WTP/ WTA. Another alternative is to use Human Capital Approach (the one use in this study) based on the calculation of: Value of Statistical Life (VOSL): discounted sum of the individual's future (marginal) contributions to the social product, which corresponds to future labour income, considering that wages are equal to the value marginal product. Non-Fatal Accidents: 13 % of VOSL for severe injuries and 1 % for slight ones. (European Commission, 2014)	$ACS = \sum_{y=1}^{n}(NFACS_{tc} + FACS_c)$ Where, ACS =Benefits from total accidents cost reduction $NFACS$=Benefits from total non-fatal accidents cost reduction. $FACS$=Benefits from total fatal accidents cost reduction. y = evaluation years of life duration of the project. c = Type of accident cost (direct or indirect) t = Type of accident (severe or slight) **Fatal accidents cost reduction (FACS)** are equal to the sum of **direct fatal accidents cost reduction (DFACS)** and **indirect fatal accidents cost reduction (IFACS)** $FACS = \sum_{y=1}^{n}(DFACS + IFACS)$ Where, DFACS=Value of direct fatal accidents cost reduction IFACS=Value of indirect fatal accidents cost reduction y = evaluation years of life duration of the project. **Indirect fatal accidents cost reduction (IFACS)** are measured by calculating the **Value of Statistical Life (VOSL)** $IFACS = \sum_{y=1}^{n}(b_f - b_o)x\,VOSL$ Where, y = evaluation years of life duration of the project. bf=Number of fatal accidents after the project bo=Number of fatal accidents before the project VOSL = Value of Statistical Life And, $VOSL = \sum_{t}^{T}\frac{w_t}{(1+i)^t}$ Where, y = evaluation years of life duration of the project. bf = Number of fatal accidents after the project b_o = Number of fatal accidents before the project T = Remaining lifetime t = Average age of death i = social discount rate w = average income per habitant **Non-Fatal accidents cost reduction (NFACS)** are equal to the sum of **direct non-fatal accidents cost reduction (DNFACSt)** and **indirect non-fatal accidents cost reduction (INFACSt)** $NFACS = \sum_{y=1}^{n}(DNFACS_t + INFACS_t)$ Where, DNFACS=Value of direct non-fatal accidents cost reduction INFACS=Value of indirect non-fatal accidents cost reduction

		t = Type of accident (severe or slight) y = evaluation years of life duration of the project. **Direct non-fatal accidents cost reduction (DNFACS)** are measured as the reduction in the number of severe non-fatal accidents (NSA) value at 18% of VOSL and the reduction in the number of slight accidents value at 15% of VOSL. $$DNFACS = \sum_{y=1}^{n} \left[\left[\left(NSA_f - NSA_o \right) * 0.18\, VOSL \right] + \left[\left(NLA_f - NLA_o \right) * 0.15\, VOSL \right] \right]$$ Where, y = evaluation years of life duration of the project. NSA_f = Number of severe non fatal accidents after the project NSA_o = Number of severe non fatal accidents before the project NLA_f = Number of slight non fatal accidents after the project NLA_o = Number of slight non fatal accidents before the project VOSL = Value of Statistical Life **Non-Fatal accidents cost reduction (NFACS)** are equal to the sum of **direct non-fatal accidents cost reduction (DNFACSt)** and **indirect non-fatal accidents cost reduction (INFACSt)** **Indirect non-fatal accidents cost reduction (INFACS)** are measured as the reduction in the number of severe non-fatal accidents (NSA) value at 13% of VOSL and the reduction in the number of slight accidents value at 1% of VOSL. $$INFACS = \sum_{y=1}^{n} \left[\left[\left(NSA_f - NSA_o \right) * 0.13\, VOSL \right] + \left[\left(NLA_f - NLA_o \right) * 0.1\, VOSL \right] \right]$$ Where, y = evaluation years of life duration of the project. NSA_f = Number of severe non fatal accidents after the project NSA_o = Number of severe non fatal accidents before the project NLA_f = Number of slight non fatal accidents after the project NLA_o = Number of slight non fatal accidents before the project VOSL = Value of Statistical Life
4. **Road maintenance cost savings – possibly negative- (M)**	Evaluated as the reduction in maintenance cost per km of the road with the project and the reduction of time between periodic and routine maintenance cost.	$$M = \sum_{y=1}^{n} \left(MC_f - MC_o \right)$$ Where, M_{kf} = Maintenance cost with the project per km. M_{ko} = Maintenance cost without the project per km. y = evaluation years of life duration of the project. And, $$MC = \sum_{y=1}^{n} (P_k + R_k) * \ km$$ MC = Maintenance cost P_k = Periodic maintenance cost per km. CFAF/km. R_k= Routine maintenance cost per km. CFAF/km. km = Number of km of the road. y = evaluation years of life duration of the project.

[20] The evaluation of fatal accidents direct costs was not developed due to lack of data to calculate it.

Indirect Benefits	Description	Economic Evaluation
1. **Value of environmental impact (negative benefit) (EI)**	Economic value of the level of pollution that the new road will introduce to the system due to a higher usage of it quantified by the increase number of cars using the road and the average amount of CO2 emissions per vehicle per km.	$$EI = \sum_{y=1}^{n}(Co2_f - Co2_o) * pCo2$$ Where, Co2f = Amount of Co2 emissions with the project in metric ton. Co2o = Amount of Co2 emissions without the project in metric ton. pCo2 = price of CO2 emissions CFAF/metric ton. y = evaluation years of life duration of the project. And $$Co2 = \sum_{y=1}^{n}(Co2_p * te) * km$$ t_e = Total traffic in number of vehicles. $Co2_p$ = CO2 emissions per km and per vehicle. In metric ton/km km = Number of km of the road. y = evaluation years of life duration of the project.
2. **Value of job creation during implementation period (Ji) (NSW Government, 2013)**	Increase of gross employment in the national economy during the implementation and usage of the road, for example O&M period during the life duration of the road.	$$Ji = \sum_{y=1}^{n}(r * e_o)$$ Where, r = average salary per employee during implementation period (CFAF/year) e_o = number of new jobs during implementation period n = number of years of life duration of the project.
3. **Increase in local earnings/infrastructure due to setting up of new enterprises (Re)**	Revenues generated by additional activities that were incentivize by the project after its implementation. It can include services like restaurants, motorway services, etc.	$$R_e = \sum_{x=1}^{n}(i)$$ Where, i = cost from additional activities created due to the project. n = number of new enterprises created during the life duration of the project.

3.2.2 Benefits calculation of electricity generation projects

Investments in power generation capacity can be developed to either achieve a higher quality of generation or increase the level of production. These goals could imply the rehabilitation of existing power plan, construction of new facilities or plants decommissioning.

The analysis required basic information concerning:

- Location, scale and purpose of the project (e.g. meet increase in demand, enhance reliability and security of supply, replace obsolete capacity, supply-demand gap reduction, etc.).
- Type of technology.
- The full investment cost, including relevant investments needed in new electricity connections, the phasing of the investments, and operating costs.
- The supply/demand situation and expected development: main customers, average and peak electricity demands, long-term off-take arrangements for electricity and/or heat if relevant.
- Price of energy with individual generators.
- Daily national demand across a year.
- Installed capacity (MW).
- Additional capacity brought by the infrastructure.
- Estimation of negative externalities (pollution)[21].

For electricity generation infrastructure projects, four direct benefits are evaluated: 1) Value of the improvement or preservation of the security of supply, 2) Value of fuel cost savings, 3) Revenues from electricity sales (if applicable), and 4) Environmental Impact.

[21] A detail description of required information is presented in annex 3

Table 6 Benefits calculation of electricity generation projects

Direct Benefits	Description	Economic Evaluation
1. Value of the improvement or preservation of the security of supply (SS):	Evaluated on the planned reduction of energy interruptions and measured considering the Value of Lost Load (VOLL) or Cost of Energy Not Served (CENS). CENS is the value that represents a customer's willingness to pay for a reliable electricity service, usually measured in monetary units per unit of energy (CFAF/GWh). In order to calculate the CENS, an estimation of energy not served (ENS) is needed: ENS is the amount of demand that is not served due to the lack of generation capacity in the system, usually measured in units of power or energy (MW or GWh).	$SS = \sum_{y=1}^{n}(ENS_f - ENS_o)\ x\ CENS$ Where, ENSo = Energy Not Served without project ENSf = Energy Not Served with project n = number of years of life duration of the project CENS = Cost of energy not served $CENS = \sum_{h=1}^{n}[ENS * c]$ Where, ENS = Energy Not Served c = Variable cost of Marginal Unit of the system $ENS = \sum_{h=1}^{n}(Px\ t)$ Where, P = Power interrupted in GW t = Time duration of fault in hours n = Number of hours in the year
2. Value of fuel cost savings (CS)	Evaluated by the reduction in fuel costs due to technological changes, in monetary unit/unit of electricity produced.	$CS = \sum_{y=1}^{n}[(VC_f - VC_o) * \mathrm{P}]$ Where, n = number of years of life duration of the project. VC_f = Variable Production cost with the project in CFA /kWh VC_o = Variable Production cost without the project in CFAF /kWh P = Electricity production in GWh
3. Revenues from electricity sales (R) if applicable	Revenue from electricity sales for the public utility.	$R = \sum_{y=1}^{n}(E_h x\ t)$ Where, p_f = Energy price after the project in CFA/MWh E_h = Energy production in each hour in GWh. p_o = Energy price before the project in CFA /MWh

		EC_o = Total energy consumed before the project in MWh
4. Value of Environmental impact (EI)	Economic value of the pollution that the new power plant will introduce to the system, it can be positive or negative depending on the type of technology of the power plant.	$$EI = \sum_{y=1}^{n} (Co2_f - Co2_o) * pCo2$$ Where, Co2f = Amount of Co2 emissions with the project in metri Co2o = Amount of Co2 emissions without the project in metric ton. pCo2 = price of CO2 emissions CFA/metric ton. n = number of years of life duration of the project.
Indirect Benefits	**Description**	**Economic Evaluation**
5. Value of job creation during implementation period (Ji)	Evaluated by the increase of employment in the country during the investment and operational stage. It can be measure along the construction stage of the project and all its value chain. (IRENA, 2013)	$$Ji = \sum_{y=1}^{n} (r * e_o)$$ Where, r = average salary per employee during implementation period (CFAF/year) e_o = number of new jobs during implementation period n = number of years of life duration of the project.

4 Economic Evaluation of Electricity Projects

4.1 Power Generation Expansion (MLI0092)

4.1.1 Description of the project

The project consists in the construction of a thermal power plant operated by Heavy Fuel Oil (HFO) to increase the power generation capacity in Mali. At project's appraisal stage in 2007, the station was designed to produce 60 MW with six engines of 10 MW each. The objective of the project is to alleviate the electricity shortages and secure the power supply of the interconnected grid serving Bamako and its suburbs. The generation capacity expansion consisted of: 1) Balingue power plant with 40 MW and

2) Sirakoro power plant with 20 MW. The total cost was estimated to EUR 52.274 million with a projected implementation period of 20 months. The expected enter into operation of the project was in 2009. (IsDB, 2007)

The project is part of an existing diesel power plant ("Balingué" by its name in French) with a maximum capacity of 32 MW. "BID Balingué"-project (given name by EDM) power plant is installed in the existing Balingue's location connected to Sirakoro sub-station in Bamako suburbs. The project released the power constraints of the existing plan where loading reached critical values with significant probabilities of provoking potential cascade tripping. (IsDB, 2007)

Due to contractor's bidding process the total capacity of the plant had to be downsized to 45 MW by the installation of four Wartsila motors of 12.15 MW each unit, instead of six units. The exact date of enter into operations of the power plant was 2011 with a total installed capacity of 48.6 MW.

The overall goal is to improve the social and economic conditions by improving the electricity supply available in the interconnected area and meet the country's development needs in terms of quality of life of the population and industrial competitiveness. (IsDB, 2015)

By 2015, the availability of the power plant was between 92% and 95% to meet the growing demand. Another important feature is that the project represents 56.2% of EDM total thermal generating capacity alleviating the load of the old plant, and reducing the reliance on hydropower generation from 77% in 2013 to 53% in 2013, minimizing hydrological hazards. (IsDB, 2015)

Capital expenditures (CAPEX) were USD 52 million[22], 12 % lower than the projected amount due to re-design of the project and reduction of its power capacity. The disaggregated estimation of actual CAPEX is shown in table 7.

[22] Value calculated based on Table 4 information and the exchange rate of May 17th 2017 taken from http://www.xe.com/fr/currencyconverter/convert/?Amount=1&From=XOF&To=USD

Table 7 Disaggregated estimated and actual CAPEX (million euros) Mali´s power generation expansion

No.	Component	Expected Cost	Real cost	Variation from initial plan
1	Equipment	45.00 €	45.16 €	0.36%
2	Consultant	1.00 €	0.49 €	-50.70%
3	Project Management Unit	0.16 €	0.16 €	0.00%
4	Audit	0.10 €	0.03 €	-75.00%
5	Base cost	46.26 €	45.84 €	-0.91%
6	Physical contigencies 8%	3.70 €	0.00 €	-100.00%
7	Financial contingencies 5%	2.31 €	0.00 €	-100.00%
	Total	52.27 €	45.84 €	-12.31%

Source: National Project Offices, 2016

4.1.2 Economic Evaluation at Appraisal

In 2007 at the appraisal stage, IsDB made an economic evaluation of the project. It was developed at aggregated level, including all other facilities under EDM management.

The main considerations of the economic evaluation were:

The demand forecast up to 2025 was established based on the annual growth rate of consumption (12%). An additional consumption increment of 2,171 GWh was taken into account in response to future connections in the RI.

The supply development plan considered the installation of new hydroelectric facilities: Centrale Félou, Kénié and Gouina; with a total capacity of 99.3 MW and an expected annual production of 485 GWh as it is shown in table 8. The expansion of interconnection capacity with Côte d'Ivoire, Guinea and Burkina Faso-Ghana[23] was also considered with 515 MW of capacity and an expected production of 3,460 GWh per year.

[23] Part of West African regional transmission network from West Africa Power Pool (WAPP)

Table 8 New investments plan 2007-2025 within the Interconnected Mali´s System –RI-

New generation development plan	Investment in capacity (MW)	Investment in energy (GWh)
New investments in hydro	99	485
New capacity from interconnections	515	3 460

Various discount rates were used for the analysis starting from 3% up to 5% during the life duration of the project.

The amount of network losses was 18.7% during the whole period with an average HFO price of 229 CFAF/l, and an average electricity tariff of 100 CFAF/kWh and CENS of 10 CFAF/kWh.

The Economic Rate of Return (EIRR) at appraisal was 19.61%, as shown in table 9 with an ENPV of CFAF 82,367 million for a discount rate of 3%, a value of CFAF 70,356 for 4% and CFAF 60,015 million for 5% respectively. After the appraisal period, the project suffered from a downsized in capacity from 60 MW to 45 MW, hence a negative impact in economic indicators. The economic profitability of the project experienced a reduction (EIRR) of 1.69 percentage points, reaching an amount of 17.92% and almost a 50% reduction in the ENPV to CFAF 54,717 million for a discount rate of 3% or CFAF 39,934 million for a discount rate of 5%. (IsDB, 2007)

Table 9 Economic evaluation results at appraisal

	Evaluation at appraisal			Updated appraisal evaluation methodology			Net variation		
EIRR	19.61%			17.92%			-1.69%		
Discount rate	3%	4%	5%	3%	4%	5%	3%	4%	5%
ENPV (MCFAF)	82,366	70,356	60,015	54,716	46,808	39,933	-27,649	-23,547	-20,081

The unique benefit considered for the economic evaluation at appraisal was the avoided economic losses due to the increase in security of supply with the entry into operation of the power plant.

4.1.3 Post Economic Evaluation

Main considerations for the proposed methodology[24]

General considerations

- The analysis is performed in Mali´s RI without considering isolated areas.
- The benefits from changes in power exchanges between neighboring countries are not considered as there is no impact. Power exchanges are considered base load generation[25].
- Fuel consumption is calculated based on fuel price during the evaluation period considered at appraisal.
- The evaluation period will be the one corresponding to the one at appraisal (since the entry into operation to 2025) as indicated by IsDB.
- The demand growth in Mali's RI includes the demand growth of current network, new connections in the region of Bamako and north of the country; and the connection of isolated self-producers after the regional interconnection with Ghana, Burkina Faso and Guinea.

Quantitative assumptions

- CO2 emissions cost: 0.01 MCFAF/MTCO2.[26]
- Annual energy production forecasted: 377.30 GWh
- Load factor of the plant for production forecasting: 88.6%
- CENS since 2017-2025: 350 CFAF/kWh.[27]
- Real discount rate: 6.23%.

Main inputs for the calculation (based on information receive from the bank and beneficiaries)

- Over cost of diesel over HFO fuel: 47 CFAF/KWh

[24] In addition to the basic assumptions presented in section 3, the following assumptions are also considered:
[25] Base load generation is all the generation that is dispatch with priority due to its low price or technical characteristics.
[26] 8034.16 CFAF/MTCO2 for 2010-2015, 9373.19CFAF/MTCO2 for 2016-2020 and 10265.88 CFAF/MTCO2, values with an equity coefficient for Sub-Saharan Africa based on United States Environmental Protection Agency in 2016. (Economics e-journal, 2011)
[27] A reduction of 150 CFAF/kWh was considered responding to the investment development plan that will expand the power generation park in the country in the following years.

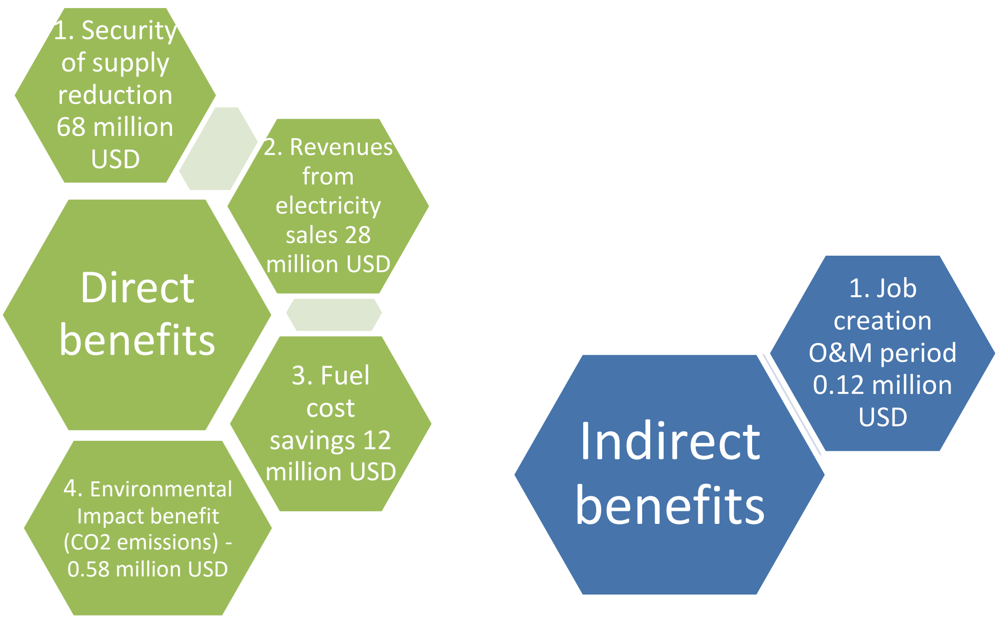
- Annual demand growth: 16%
- Technical losses: 19%
- CENS: 550 CFAF/kWh.
- Annual salary per worker during operation and maintenance of the power plant: 500,000 CFAF/year
- Employees during O&M phase of the road: 30 employees.
- Average efficiency of the plant: 214.98 g/kWh (IsDB, 2015)

Results

Four different direct benefits[28] were calculated for the project: 1) Value of supply-demand gap translated in security of supply reduction with USD 68 million, 2) Revenue from electricity sales with USD 28 million, 3) Benefits from fuel cost savings with USD 12 million, 4) Environmental impact benefit (CO2 emissions) with USD -0.58 million.

The indirect benefit applicable was job creation during O&M of the power plant with USD 0.12 million as it is presented in figure 3. All detailed charts of economic evaluation are presented in Annex 2.

Figure 8 Direct and indirect benefits calculated for Mali´s power generation project



[28] Discounted values calculated with an exchange rate of May 17th 2017 taken from http://www.xe.com/fr/currencyconverter/convert/?Amount=1&From=XOF&To=USD

The realised investment cost of the project was USD 51.06 million. During the period 2010-2025, the project will provide an economic return of USD 872.57 million at the end of its life duration in contrast to USD 341.66 million of economic costs[29]. The obtained EIRR is 29%, 9 percentage points higher than the one calculated at appraisal when considering additional benefits and after updating the final installed capacity of 15 MW less than the original dimension.

With a 6.23% discount rate, the ENPV is USD 500 million and a benefits/cost ratio of 2.55, more than twice the total economic costs of the power plants.

Table 10 Economic results from Mali´s electricity 45 MW Power Plant -6.23% discount rate-

Indicator	CFAF million	EUR million	USD million*
Total investment	30 068.41	45.84	51.06
Total discounted benefits	513 828.81	783.33	872.57
Total discounted costs	201 196.00	306.72	341.66
Benefits/Costs Ratio	2.55	2.55	2.55
EIRR	29%	29%	29%
ENPV	294 298.04	448.65	499.77

*Exchange rate May 17th 2017.

Figure 9 shows the discounted benefits, discounted costs and accumulated ENPV from 2007 to 2025. Discounted benefits presents an irregular variation mainly due to the fluctuation in the realised and expected ENS during the analysed period – dependent on the availability of energy and decommissioning of other power plants within Mali´s RI. Discounted costs are more stable with a slight negative trend from 2010 to 2025. Finally, the accumulated ENPV shows that the expected break-even is in 2017 approximately, with a positive trend after it until 2025.

[29] Economic costs include investment cost and all incurred cost during O&M during the evaluation period.

Figure 9 Power Generation Expansion BID Balingué Mali

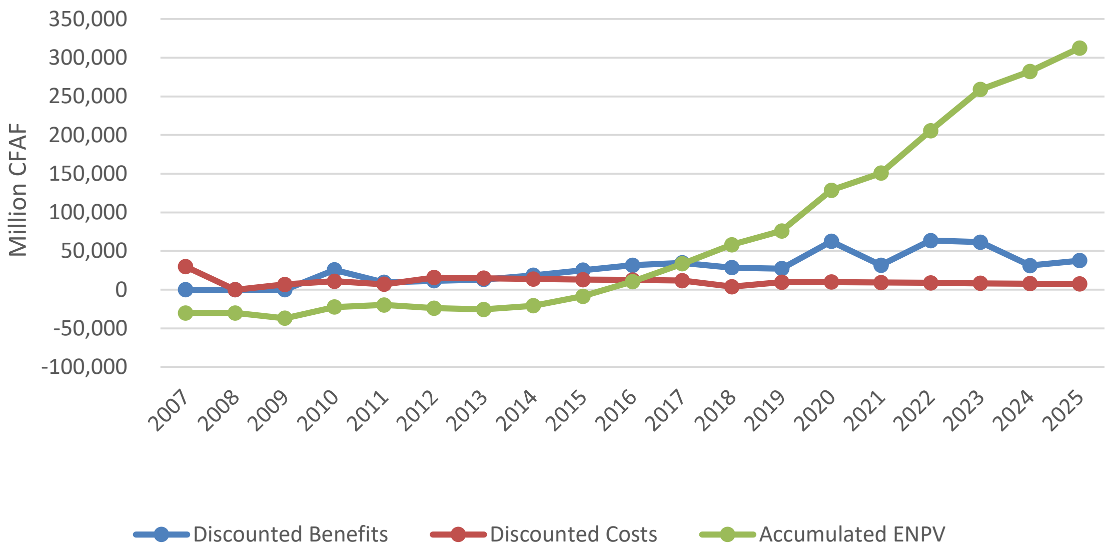
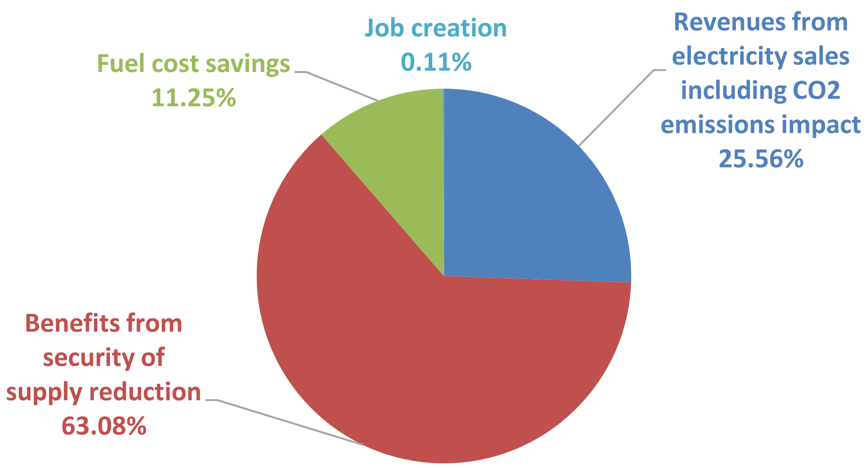


Figure 10 shows the expected benefits participation during the evaluation period for Balingué Mali´s power plant, where 63% corresponds to benefits from security of supply reduction, followed by 26% of revenues from an increase in electricity sales and fuel cost savings at 11%. As expected indirect benefits had a lower impact reaching a participation of 0.11% for job creation.[30]

Figure 10 Expected benefits disaggregation during the evaluation period Power Generation Expansion BID Balingué Mali [31]

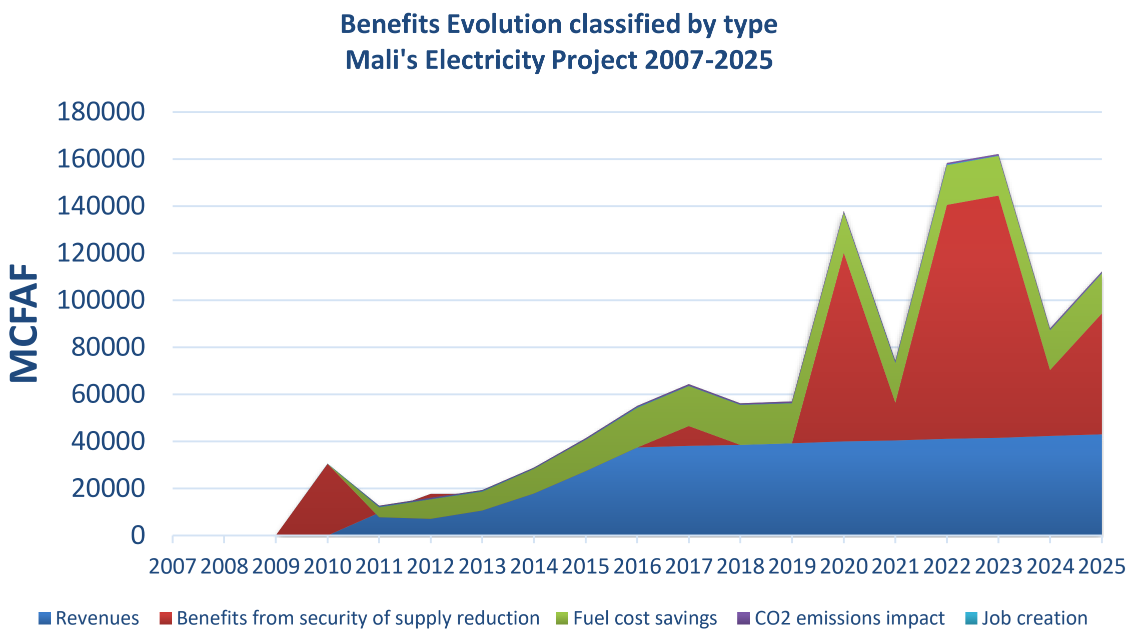


A regular increase in revenue is observed from the enter into operations until the plant reaches its nominal capacity[32], benefits from security of supply reduction have an irregular behavior considering

[30] Nominal values in USD are shown in figure 3 at the beginning of this section.
[31] CO_2 emissions impact were included in revenues from electricity sales as it has a negative impact.
[32] Forecasted energy production profile with a capacity of 45 MW and an 85% of availability during the year.

its dependency on availability and decommissioning of other power plants within Mali´s RI generation park. See figure 11

Figure 11 Benefits Evolution (classified by type) 2007-2025 Power Generation Expansion BID Balingué Mali



Sensitivity Analysis

As the main indicators of the study are ENPV and benefit/cost ratio, both indicators were calculated for different levels of discount rate to test the robustness of the developed study. In this case, the values of 5% 10%, 12%, 15% and 18% were chosen were chosen based on regularly used discount rates by international institutions for developing countries when appraising infrastructure projects and the discount rates used at appraisal.

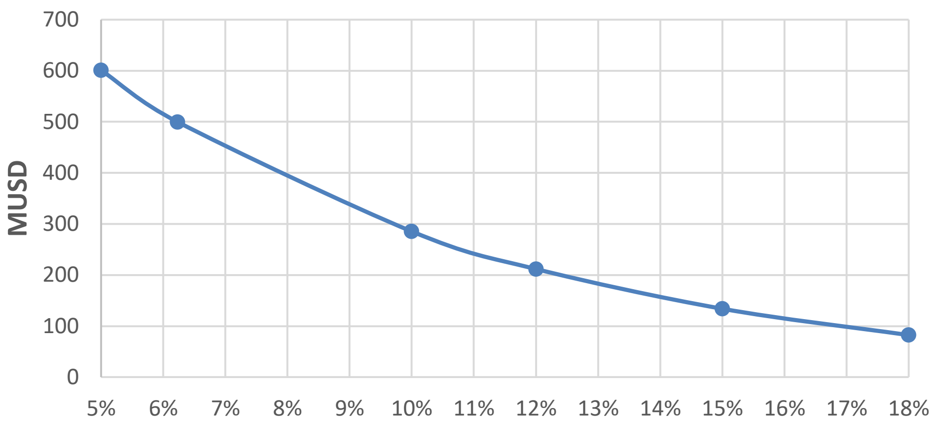
A discount rate of 10% results in an ENPV of approximately USD 286 million, 43% lower than the return with a discount rate of 6.23%. Similarly, the impact in the B/C ratio is a reduction from 2.6 to 2.0, a 23% lower in comparison with the discount rate used in the project.

Table 11 Sensitivity Analysis for different discount rates 7% - 18%

Sensitivity Analysis						
Real Discount rate	5.00%	**6.23%**	10.00%	12.00%	15.00%	18.00%
ENPV (MUSD)	601	**500**	286	212	134	83
B/C ratio	2.7	**2.6**	2.2	2.0	1.8	1.6

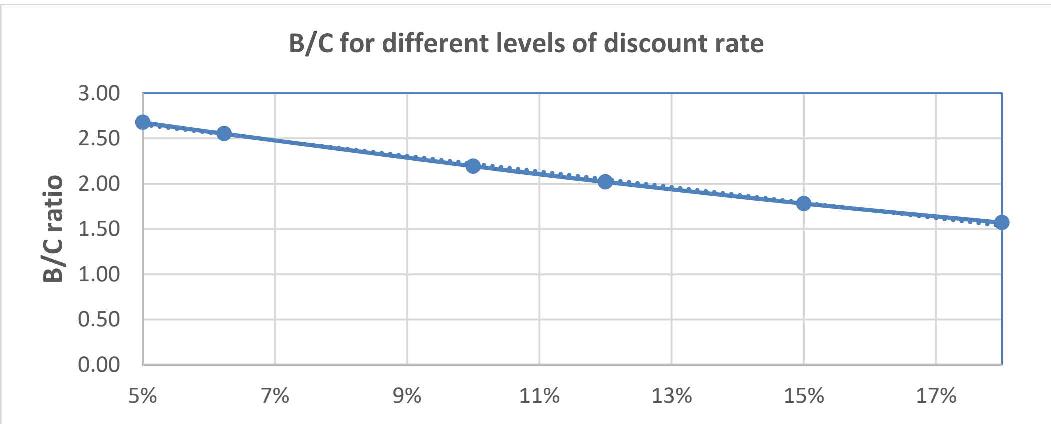
As shown in figure 12, ENPV is very sensitive to a change in discount rate. In addition, higher values of discount rates generate a lower impact in ENPV, as the discount rate increases, the impact decreases flattering the curve.

Figure 12 Sensitivity analysis ENPV – Discount rate Power Generation Expansion BID Balingué Mali



On the other hand, changes in discount rate has less impact on B/C than on the ENPV, for example a change of 24% in the discount rate only generates a reduction of 14% in the B/C ratio. Likewise, higher values of discount rates generate a lower impact on the B/C than on ENPV. See figure 13.

Figure 13 Sensitivity analysis B/C ratio – Discount rate Power Generation Expansion BID Balingué Mali

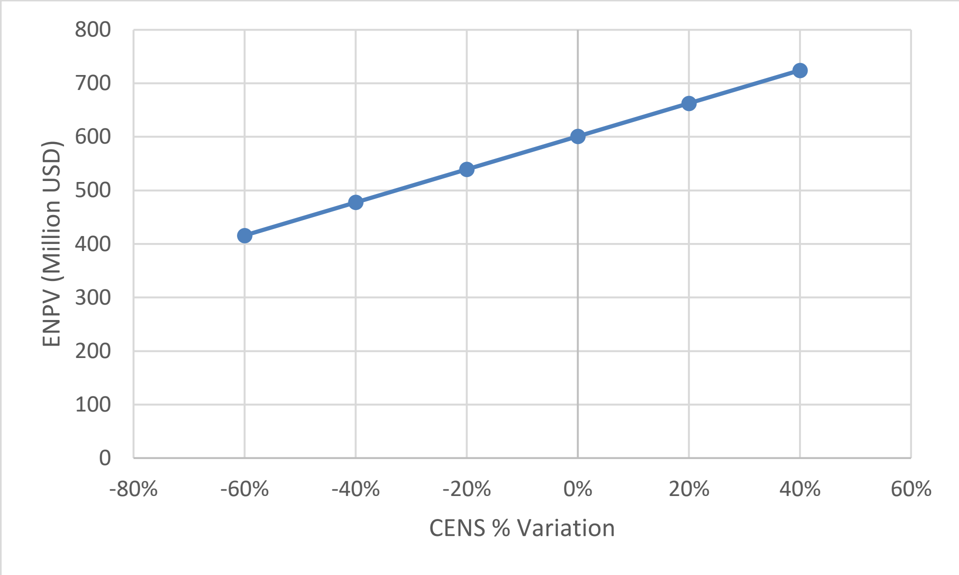


One of the key variables of the project is the CENS. When testing the impact of changes in CENS in ENPV and EIRR, the following results were obtained:

Table 12 Sensitivity analysis of ENPV to different CENS

CENS variation	-60%	-40%	-20%	0%	20%	40%
ENPV	415.76	477.42	539.07	600.73	662.38	724.04
		15%	13%	11%	10%	9%

Figure 14 Sensitivity analysis ENPV – CENS Power Generation Expansion BID Balingué Mali



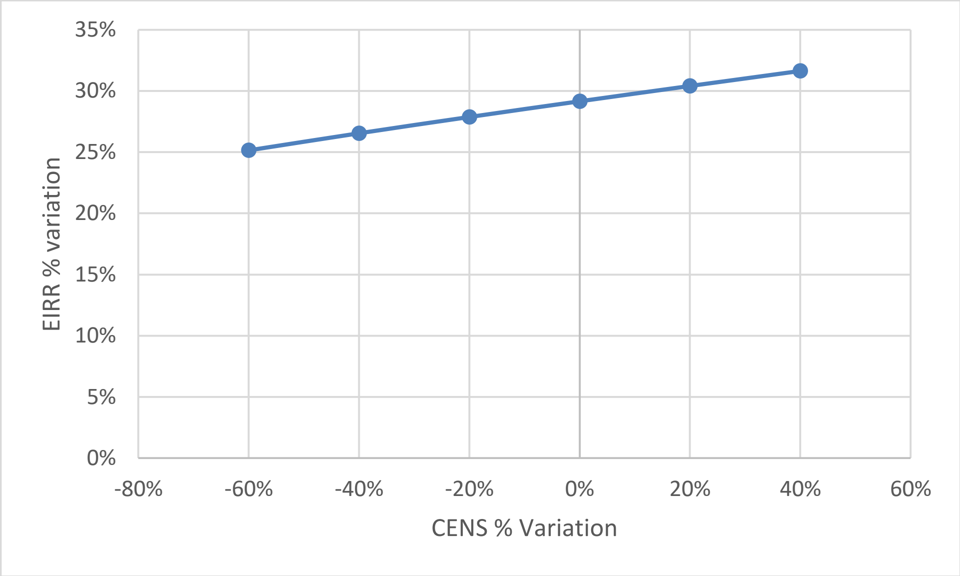
As it is observed in figure 14, ENPV is not highly sensitive to changes in CENS. In addition, CENS is directly proportional to ENPV as it generates a positive impact due to the existence of ENS. Variations of 20% in CENS value doesn´t affect the return of the project generating an impact of less than 15% for lower values of CENS and an impact of 10% approximately for higher changes in CENS value.

In the same line, EIRR is less sensitive to changes of 20% in CENS. As it is observed in table 13, a change of 20% in CENS only generates an impact of 6% at most in the EIRR, confirming the robustness of the analysis performed. When comparing the behavior of ENPV versus CENS (figure 14) and EIRR versus CENS (figure 15), it is observed that ENPV is more sensitive than EIRR to a change in CENS.

Table 13 Sensitivity analysis of EIRR to different CENS BID Balingué Mali

CENS variation	**-60%**	**-40%**	**-20%**	**0%**	**20%**	**40%**
EIRR	25%	27%	28%	29%	30%	32%
% Variation		6%	5%	5%	4%	4%

Figure 15 Sensitivity analysis EIRR – CENS Power Generation Expansion BID Balingué Mali



5 Economic Evaluation of Road Projects

5.1 Upgrading of Dakar Expressway (SEN0096)

5.1.1 Description

Upgrading of Dakar Expressway is a project developed to improve the urban mobility in Dakar city and its surroundings, thus generating an important socio-economic benefits for the country. Pursuing this goal, the dual expressway (VDN by its name in French), with a length of 5.7 Km, was improved, including the construction of 3 grade-separated interchanges and related access roads.

Apart from the main objective, the scope of the additional works also included all related bridge widening works, displacement of public utility networks and landscaping works. The components include the following: (i) widening of the OMVS interchange bridge to a 2x2 lanes structure, (ii) displacement of public utility networks, (iii) construction of three foot-bridges and (iv) landscaping works. (IsDB, 2008)

All additional works listed above were done between 2007 and 2009 with a delay between its authorisation and construction period. One of the issues generated by the construction of the main works was a harsh increase in the number of pedestrian accidents caused by the unavailability of footbridges after the upgrade of the highway. The cost of civil works was 54% higher than estimated at the appraisal, while the one for consultancy was 24% lower. Finally, the total construction cost was 35% higher than anticipated. (IsDB, 2015)

Table 14 Disaggregated estimated and actual CAPEX (million EUR) Mali´s power generation expansion

No.	Component	Expected Cost	Real cost	Variation from initial plan
1	Civil work (Upgrading VDN and construction of 3 exchangers	$31.86	$49.15	54.25%
2	Consultant	$1.59	$1.20	-24.42%
3	Audit	$0.06	$0.00	-100.00%
4	Project Management Unit	$0.38	$0.00	-100.00%
5	Contingencies	$3.29	$0.00	-100.00%
	Total	**$37.18**	**$50.35**	**35.42%**

Source: IsDB, 2015

5.1.2 Economic Evaluation at Appraisal

Performing a comparative analysis with economic evaluation at appraisal was not possible due to missing information on economic evaluation of *ex-ante* evaluation.

5.1.3 Post Economic Evaluation

Main considerations for the proposed methodology[33]

General considerations

- The evaluation ranges from 2011 (the entry into operation) to 2030 (working life of the road).
- Accidents includes all accidents for drivers, passengers and pedestrians. (SEN, 2017)
- Mortal and non-mortal accidents growth were forecasted at the existing traffic growth rate.

[33] In addition to the basic assumptions presented in section 3, the following assumptions are also considered:

Quantitative assumptions

- Annual demand growth for existing traffic: 3.5%.
- Annual demand growth for generated traffic: 30% of existing traffic.
- Job creation during O&M: 4.66% from value of created jobs during construction period.[34]
- Annual growth in O&M of the road: 10% was taken into consideration due to the degradation of the road. [35]
- CO2 emissions cost: 0.01 MCFAF/MTCO2.[36]
- Coefficient for VOC savings with the project calculation: 0.94.[37]
- VOSL: CFAF 4.58 million.
- Direct and indirect costs for non-mortal accidents are based on VOSL calculation with the following coefficients:

Table 15 VOSL coefficients for accidents cost savings valuation

Valuation of non-mortal accidents	Direct cost	Indirect cost	Total
Severed injuries	15%	13%	28%
Light injuries	18%	1%	19%

Source: (European Commission, 2014)

- Co2 emissions per vehicle: $2.55\text{x}10^{-4}$ metric ton per km [38]
- Passenger car unit: 3.
- Real discount rate: 8.27%.

Main inputs for the calculation (based on information receive from the bank and beneficiaries)

- Average travel time for road users: 8 minutes without the project; 6 minutes with the project.
- VOC per vehicle: 209.34 CFAF/km without the project. [39]
- Road length: 5.7km.

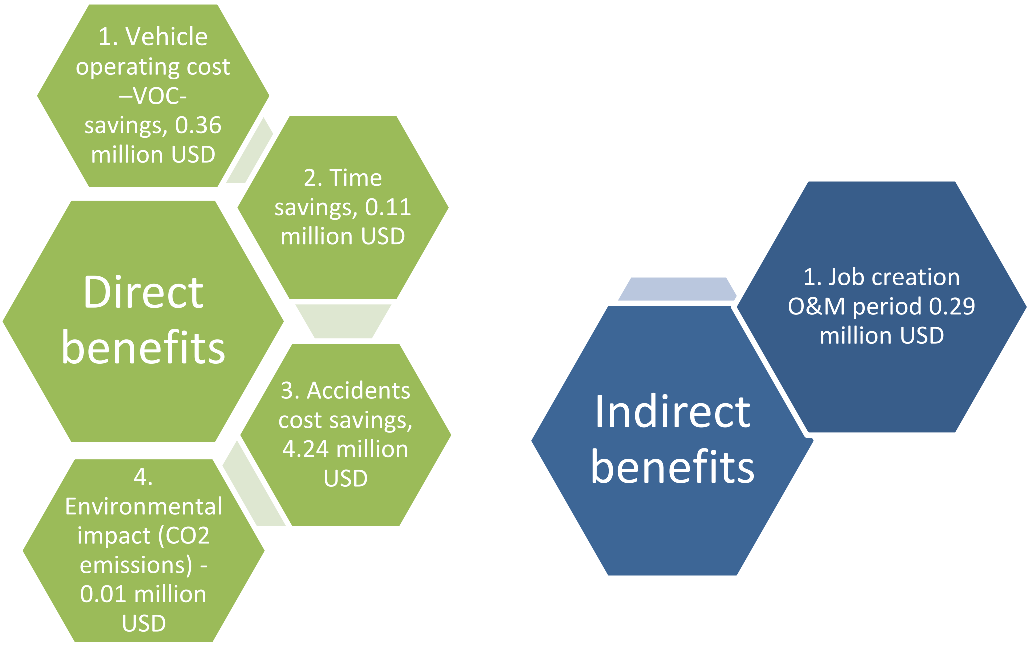
[34] Coefficient calculated based on the proportion of operation and maintenance cost with respect to total investment of the project.
[35] Conservative scenario due to the degradation of the road.
[36] 8034.16 CFAF/MTCO2 for 2010-2015, 9373.19CFAF/MTCO2 for 2016-2020 and 10265.88 CFAF/MTCO2, values with an equity coefficient for Sub-Saharan Africa based on United States Environmental Protection Agency in 2016. (Economics e-journal, 2011)
[37] Coefficient applied to VOC without the project to calculate VOC with the project. The coefficient was calculated in function of speed changes for all users.
[38] Standard value taken from (EPA, s.f.)
[39] Average value calculated for five different types of vehicle presented in (DTR, 2014)

- Income per habitant: CFAF 376,233 per year. [40]

Results

Three different direct benefits are calculated for the project: 1) VOC savings with USD 0.29 million, 2) time savings with USD 0.09 million, 3) accidents cost savings with the highest economic return of USD 3.40 million, 4) Environmental impact (CO2 emissions) with a negative impact of USD -0.01 million[41]. The indirect benefits calculation applicable for this project were job creation during O&M of the road with USD 0.23 million as it is presented in figure 7. [42] All charts and economic cash flows are presented in Annex 2.

Figure 16 Discounted direct and indirect benefits calculated for Dakar Expressway Project



At a discount rate of 8.27%, the total costs were USD 50 million almost the entirely investment cost and the benefits were USD 100 million resulting in a benefits to cost ratio (B/C) of 2. The EIRR was 15% and the ENPV USD 69 million.

[40] (Senegal's Road National Authorities, 2017)
[41] Maintenance cost savings couldn´t be calculated due to missing data for with and without scenarios.
[42] Benefits results corresponds to the discounted values calculated with an exchange rate of May 17th 2017 taken from http://www.xe.com/fr/currencyconverter/convert/?Amount=1&From=XOF&To=USD

Table 16 Economic results from Dakar Expressway -8.27% discount rate-

Indicator	CFAF million	EUR million	USD million
Total discounted investment	28 720.72	43.78	48.77
Total discounted Benefits	58 830.95	89.69	99.90
Total discounted Costs	29 135.04	44.42	49.48
Benefits/Costs Ratio	2.02	2.02	2.02
EIRR	15%	15%	15%
ENPV	40 773.12	62.16	69.24

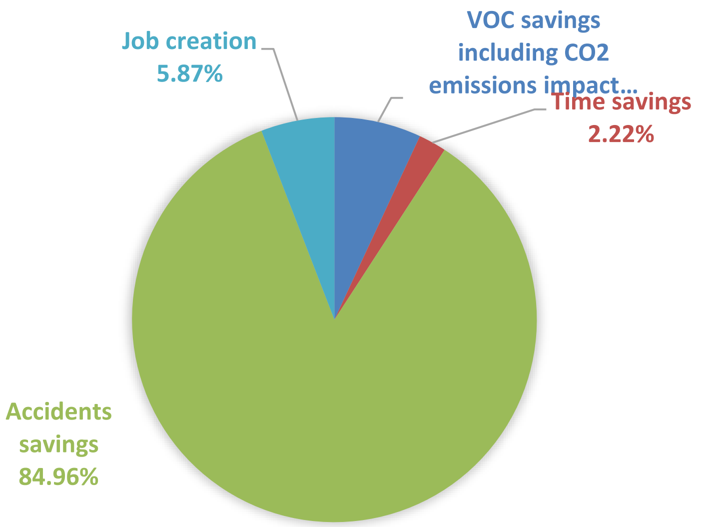
* exchange rate to 17 may 2017 from http://www.xe.com/fr/currencyconverter/convert/?Amount=1&From=XOF&To=USD

Figure 17 shows the discounted benefits, discounted costs and accumulated ENPV across the period. Discounted benefits during the life duration of the road were similar to the behavior presented by discounted costs. Finally, the accumulated ENPV shows that the expected break-even of the project is in 2018 with an increasing behavior after it, until 2030.

Figure 17 Upgrading of Dakar Expressway (SEN0096)

Similarly, figure 18 shows the expected benefits participation during the evaluation period for Dakar Expressway road project, 85% will correspond to benefits from accidents cost savings, 7% for VOC savings, followed by time savings with 2%. As expected, indirect benefits had a lower impact reaching a participation for job creation and CO2 emissions of 6% and -0.26% respectively. CO2 emissions had a negative value due to the increase in traffic users with the improvement of the road.

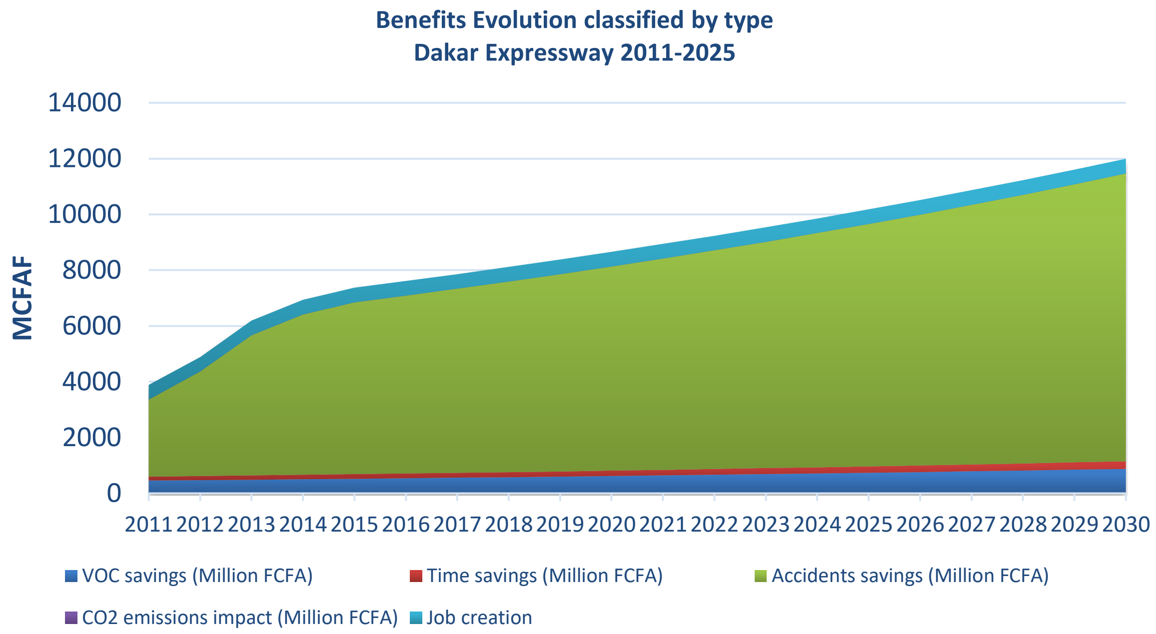
Figure 18 Expected benefits disaggregation in 2030 Dakar Expressway



During the lifetime of the project, benefits tend to increase, especially accidents cost savings experiencing a shift since 2013 due to the ending of the construction work.

Benefits from VOC and time savings have a slight positive trend with time, similar to job creation during O&M behavior.

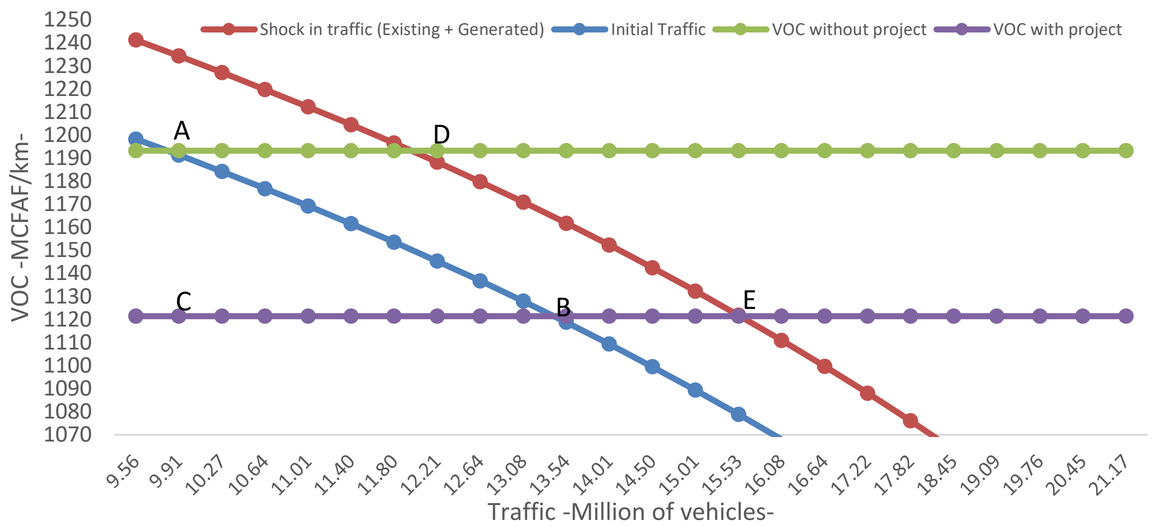
Figure 19 Benefits Evolution (classified by type) 2011-2030 Dakar Expressway



VOC savings

Figure 20 shows the impact of a change in VOC on traffic demand. The first effect is a change in traffic demand that goes from 9, 907, 044 to 13, 535, 426 vehicles due to the decrease in VOC from 1,193.25 "without the project" scenario to 1,121.47 "with the project" one. Total VOC savings for existing traffic are the area ABC. The second effect is VOC savings for generated/diverted traffic that takes place due to the shift of traffic demand due to an increase of approximately 30% in its growth reaching a value of 15,532,212 instead of 13,535,426 vehicles in response to the implementation of the project. In this last case, total benefits becomes the area ACDE.[43]

Figure 20 Impact in traffic demand due to a change in VOC



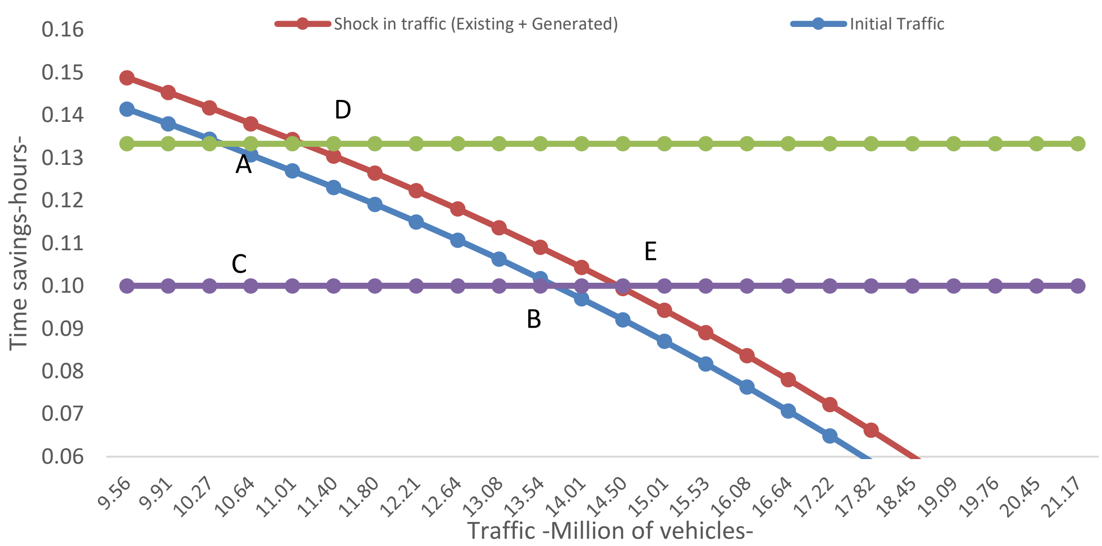
Time savings

Figure 21 shows the impact that time savings has on traffic demand. The first effect is time savings for existing traffic, where the traffic demand goes from 9, 907, 044 to 13, 535, 426 vehicles due to the decrease in 2 minutes of total travel time. The total benefits of time savings for existing traffic is ABC area. The second effect is time savings for generated/diverted traffic that takes place due to the shift of traffic demand with an increase of approximately 30%. In this last case, total benefits become ACDE area.[44]

[43] Estimated values for illustrative purposes, as traffic demand and VOC are average values. Real demand curves might differ for each type for vehicle using the road.

[44] Estimated values for illustrative purposes, as traffic demand and time savings are average values. To calculate total time savings an occupancy rate of 3 was taken into consideration.

Figure 21 Impact in traffic demand due to a change in travel time



Sensitivity Analysis

As the main indicators of the study are ENPV and benefit/cost ratio, both indicators were calculated for different levels of discount rate to test the robustness of the developed study. In this case the values of 6%, 10%, 12% and 14% were chosen based on regularly used discount rates by international institutions for developing countries when appraising infrastructure projects.

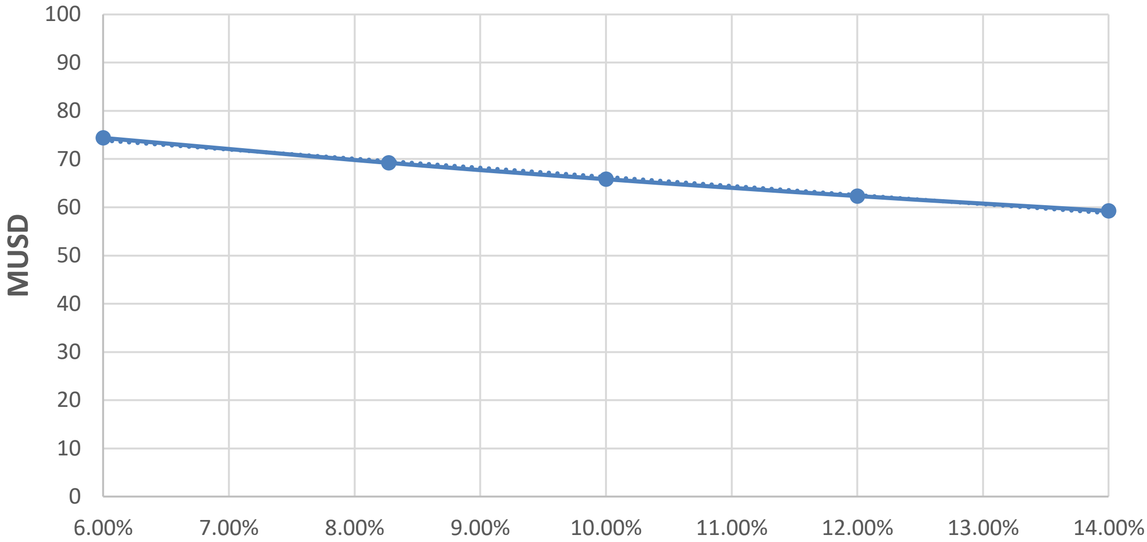
A 12% discount rate leads to an ENPV of approximately USD 59 million, 15% lower than the return with a discount rate of 8.27%. The impact in the B/C ratio is a reduction from 2.0 to 1.1, an 45% lower in comparison with the original discount rate.

Table 17 Sensitivity Analysis for different discount rates 7% - 18% Dakar Expressway

Sensitivity Analysis					
Discount rate	6.00%	8.27%	**10.00%**	12.00%	14.00%
ENPV (MUSD)	74.4	**69.2**	65.8	62.4	59.3
B/C ratio	2.6	**2.0**	1.7	1,4	1.1

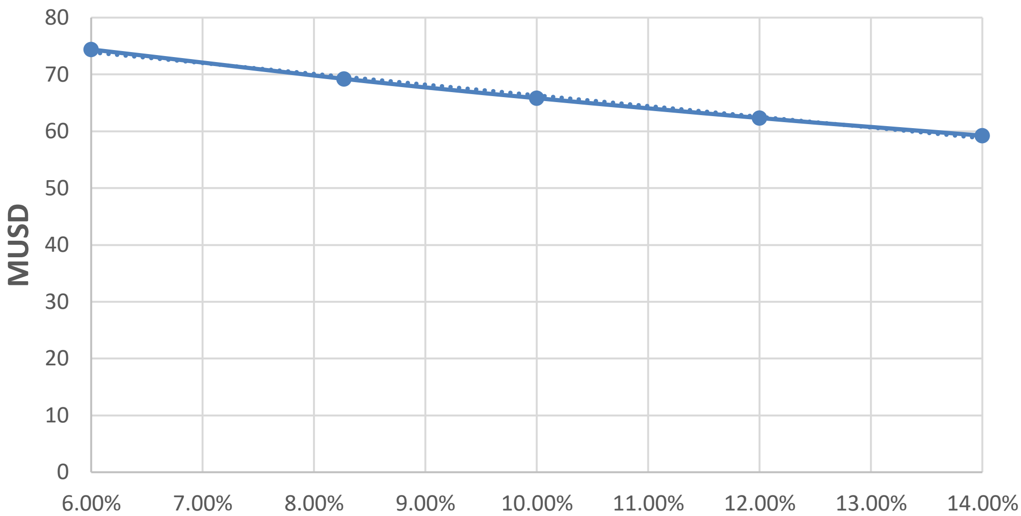
As shown in figure 22, ENPV is very sensitive to a change in discount rate, a change of 2% (from 10% to 12%) in the discount rate generates a reduction of approximately USD 3 million in the ENPV. In addition, higher values of discount rates generate a lower impact in the ENPV, as the discount rate increases the impact decreases flattering the curve.

Figure 22 Sensitivity analysis ENPV – discount rate Dakar Expressway



A variation in discount rate has more impact on the B/C ratio than on the ENPV, for example a change of 20% (from 8.27% to 10%) in the discount rate leads to a reduction by 17% of the B/C ratio and 5% in the ENPV. Likewise, higher values of discount rates generate a lower impact in the B/C, in comparison to the impact generated in ENPV indicator.

Figure 23 Sensitivity analysis B/C ratio – Discount rate Dakar Expressway



When testing different traffic growth rates for the analysis the following results were found:

Table 18 Sensitivity Analysis for different generated traffic growth rates Dakar Expressway

Different growth rates	**10%**	**20%**	**30%**	**40%**	**50%**
EIRR	15.34%	15.39%	15.44%	15.48%	15.53%
ENPV (MUSD)	75.15	75.63	76.12	76.61	77.10

As it observed in table 18, changes in different "generated traffic" growth rates have no significant impact in economic CBA indicators, what assures the consistency of the results and economic profitability of the project. Changes of 10% in growth rates generates impacts of less than 1% in EIRR and ENPV.

5.2 Construction of Saraya-Kita Regional Road Project in Senegal and Mali (MLI0079 and SEN0080)

5.2.1 Description

To improve road infrastructure, Mali and Senegal decided to build a 310 km regional road connecting road Kita – Saraya – Kédougou. This project was conducted within the common program of all member states in WAEMU region to develop roads and infrastructure.

The project aims to improve the transfer of goods and services between Mali and Senegal by completing the 371 km of the Bamako-Dakar with this regional road. The goal is also to improve traveling conditions while increasing commercial activities between the two countries and in WAEMU region in general.

Two specific objectives were defined:

1. Create a permanent road connection from the south with a good level of service between Mali and Senegal and reduce the obstacles to free circulation by decreasing transportation costs and promoting economic interchanges between both countries.
2. Improve the quality of life of the population inside the project zone.

From Mali´s side the project consisted of 270.38 km. from Kita to *Falémé River*, the natural frontier between these two countries. The *Kita – Sékokoto* part was built in 2008 with IsDB finances including the modification of access ramps for heavy vehicles.

As observed in table 19, total investment costs were 40.28% higher than the expected cost of USD 88.79 million. Real investment cost amounted USD 124.55 million.

Table 19 Disaggregated estimated and actual CAPEX (MUSD)[45]

	Expected cost (USD million)	Real cost (USD million)	Deviation from initial plan
Total investment	88.79	124.55	40.28%

Table 20 shows the disaggregated CAPEX for Saraya-Kita road project in Mali and Senegal. Total investment was USD 109 million for Mali and USD 15 million for Senegal.

Table 20 Disaggregated CAPEX (MUSD) Saraya-Kita road project for Mali and Senegal

Description	Mali in MUSD (232.23km)	Senegal in MUSD (80km)
Civil works	79.03	14.08
Civil works (Bridges)	27.17	
Control and surveillance	2.79	
Others	0.57	0.92
Total Investment	109.56	15.00

Saraya-kita road project is part of a broader road project in West Africa called Trans-Sahelian Highway that forms a strategic link through Senegal, Mali, Burkina Faso, Niger, Nigeria Cameroon and Chad, connecting five capital cities and countless towns and villages in between. One of the main advantages of the construction of this road is the connection of landlocked countries in the heart of West Africa to the ports along the coast, boosting economic integration in ECOWAS region.

The direct influence zone of the appraised project is composed of the southern *Kayes* region in Mali and the regions of *Kédougou, Bakel* and *Tambacounda* in Senegal. The area has proven mineral resources (gold, diamond, bauxite, uranium, phosphates).

The orange sections on figure 24 show the segments of the regional project financed by IsDB.

[45] exchange rate of May 17th 2017 taken from http://www.xe.com/fr/currencyconverter/convert/?Amount=1&From=XOF&To=USD

Figure 24 West Africa regional road project map

Source: (IsDB, 2014)

IDB's participation

The Board of Executive Directors from IsDB approved on 20 July 2003 two loans financing the construction of Saraya-Kita Road Project for a total amount not exceeding USD 18.899 million as follows:

1. ***Mali:*** an amount not exceeding USD 9.451 million to cover part of the cost of the Bafing river-Kita section. ECOWAS Fund, BOAD and Mali will cover the remaining cost for this section of road.
2. ***Senegal:*** an amount not exceeding USD 9.448 million to cover part of the cost of Saraya-Faleme section. OPEC Fund and Senegal covered the remaining cost for this section of road. (IsDB, 2008)

Table 21 details financing plan for IsDB components in million USD, having IsDB a financial participation of 52% from the total expected cost of the project.

Table 21 Financing plan for IsDB components

		FINANCING PLAN OF IDB COMPONENTS in US $ million											
		IDB		ECOWAS Fund		OPEC Fund		BOAD		Mali + Senegal Governments- LC			
Components	**Total**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Mali**	**Senegal**	**Total**	**%**
-1-Constr. Works	**30.462**	**15.791**	51.8%	**5.916**	19.4%	**2.074**	13.1%	**2.916**	562.5%	***2.500***	***1.265***	**3.765**	12.4%
a- Sareya-Faleme river	***11.077***	*7.738*	*69.9%*	-	*0.0%*	*2.074*	*18.7%*	-	*0.0%*	-	*1.265*	*1.265*	*11.4%*
d- Bafing river-Kita	***19.385***	*8.053*	*41.5%*	*5.916*	*30.5%*	-	*0.0%*	*2.916*	*15.0%*	*2.500*	-	*2.500*	*12.9%*
-2-Supervision (7%)	**2.132**	**1.236**	58.0%	**0.448**	21.0%	**0.000**	0.0%	**0.448**	21.0%	***0.000***	***0.000***	**0.000**	0.0%
a- Sareya-Faleme river	***0.775***	*0.775*	*100.0%*	-	*0.0%*	-	*0.0%*	-	*0.0%*	-	-	-	*0.0%*
d- Bafing river-Kita	***1.357***	*0.461*	*34.0%*	*0.448*	*33.0%*	-	*0.0%*	*0.448*	*33.0%*	-	-	*0.000*	*0.0%*
-3-Accomp. measures	**0.154**	-	0.0%	-	0.0%	-	0.0%	-	0.0%	***0.077***	***0.077***	**0.154**	100.0%
-4- Support to PMU	**0.205**	-	0.0%	**0.000**	0.0%	**0.103**	50.2%	**0.102**	49.8%	-	-	-	0.0%
-5- Audit	**0.154**	**0.154**	100.0%	-	0.0%	-	0.0%	-	0.0%	-	-	-	0.0%
Base Cost	**33.107**	**17.181**	***51.9%***	**6.364**	***19.2%***	**2.177**	***6.6%***	**3.466**	***10.5%***	**2.577**	**1.342**	**3.919**	***11.8%***
Physical conting. (5%)	**1.655**	**0.859**	***51.9%***	**0.318**	***19.2%***	**0.109**	***6.6%***	**0.173**	***10.5%***	**0.129**	**0.067**	**0.196**	***11.8%***
Financial conting. (5%)	**1.655**	**0.859**	***51.9%***	**0.318**	***19.2%***	**0.109**	***6.6%***	**0.173**	***10.5%***	**0.129**	**0.067**	**0.196**	***11.8%***
Total Cost	**36.417**	**18.899**	***51.9%***	**7.000**	***19.2%***	**2.395**	***6.6%***	**3.812**	***10.5%***	**2.835**	**1.476**	**4.311**	***11.8%***
Total -Mali	***23.098***	9.451	*40.9%*	7.000	*30.3%*	-	*0.0%*	3.812	*16.5%*	**Mali**		2.835	*12.3%*
Total-Senegal	***13.319***	9.448	*70.9%*	-	*0.0%*	2.395	*18.0%*	-	*0.0%*	**Senegal**		1.476	*11.1%*

Source: (IsDB, 2008)

5.2.2 Economic Evaluation at Appraisal

At appraisal, IsDB made an economic evaluation of the project at regional level taking into consideration Senegal and Mali's respective sections.

The main considerations of the economic evaluation were the following:

- The construction period was four years, expecting 2008 as the date of enter into operation, followed by an evaluation period that went from 2008 to 2028.
- A discount rate of 10%.
- The traffic demand forecasting was established on the basis of an annual growth rate of 3% for light vehicles and 4% for heavy ones. The values for PCU were 1.25 and 3 respectively.
- The economic benefits considered were savings on maintenance cost and savings on deviated merchandizes-tons for three different types of products: solid, petroleum and cotton.
- Three different scenarios were tested: 1) 20% of increase in project cost, 2) 20% decrease in project benefits and 3) 20% increase in project cost and 20% decrease in project benefits.

The projected investment cost at this time was CFAF 62,740.80 million.

The Economic Rate of Return (EIRR) at appraisal was 13.9%, with an ENPV of USD 22.93 million for a discount rate of 10%. An increase of 20% in project cost resulted in 11.6% of EIRR and USD 10.93 million of ENPV. A decrease of 20% in project benefits generated a decrease of 0.4 in EIRR with an economic return of 11.2% and an ENPV of USD 6.34 million. A final case scenario was considered modelling both considerations at the same time. The results obtained were an EIRR of 9.1% with an ENPV of USD 5.67 million. (IsDB, 2003)

Table 22 Economic evaluation at appraisal of Saraya-Kita regional project

	Evaluation at appraisal	Evaluation with 20% increase in project cost	Evaluation with 20% decrease in project benefits	Evaluation with 20% increase in project cost and 20% decrease in project benefits
EIRR	13.9%	11.6%	11.2%	9.1%
ENPV (Million USD)	22.93	10.93	6.34	5.67

5.2.3 Post Economic Evaluation

Main considerations for the proposed methodology[46]

General considerations

- The project is evaluated as a regional project from Saraya in Senegal to Kita in Mali to capture all economic benefits from exchanges between both countries. Within the regional project IsDB has financed road sections at both nations.
- The evaluation period considered was from 2010 until 2030, the period corresponding to the working life of the road.
- The analysis is performed with the distinction between heavy and light vehicles.
- Maintenance cost savings are the difference between existing and project conditions of the road separately in Senegal and Mali considered in economic evaluation made at appraisal. Updated values of periodic and regular maintenance cost are considered for Mali´s road with 2017 data.
- Accidents cost savings evaluation was not possible due to missing data.

[46] In addition to the basic assumptions presented in section 3, the following assumptions were also considered:

- Traded merchandizes includes solids, petroleum and cotton products. Savings in traded merchandizes are calculated from deviated rail traffic Bamako-Dakar and deviated road traffic Bamako-Abidjan.

Quantitative assumptions

- Value of job creation during O&M period: 3.26% from of job creation during construction period.[47]
- CO2 emissions cost was evaluated at 0.01MCFAF/MTCO2.[48] (EPA, 2016)
- Annual income per habitant: CFAF 388,579.[49]
- Annual demand growth for existing traffic: 3% for light vehicles and 4% for heavy ones.
- Growth rate for generated traffic: 600%[50]
- Passenger car unit: 3 for heavy vehicles and 1.5 for light ones.
- Real discount rate: 7.89%.

Main inputs for the calculation (based on information receive from the bank and beneficiaries)

- Travel time for heavy vehicles: 48 hours without the project to 12 hours with the project.
- Travel time for light vehicles: 20 hours without the project to 4 hours with the project.
- VOC per vehicle with and without the project are presented in table 23 below.

Table 23 VOC for light and heavy vehicles with and without the project (CFAF/km) [51]

	Cost per km real HTT without the project (CFAF/km/day)	Cost per km real HTT with the project (CFAF/km/day)
Light Vehicles	419	152
Heavy Vehicles	1063	467

[47] Coefficient calculated based on the proportion of operation and maintenance cost with respect to total investment of the project.
[48] 8034.16 CFAF/MTCO2 for 2010-2015, 9373.19CFAF/MTCO2 for 2016-2020 and 10265.88 CFAF/MTCO2, values with an equity coefficient for Sub-Saharan Africa based on United States Environmental Protection Agency in 2016. (Economics e-journal, 2011)
[49] Average annual salary for Mali and Senegal.
[50] (GOE, 2016)
[51] Values taken from economic evaluation at appraisal.

- An annual growth rate of 4% is used for solid and petroleum products and 3% for cotton. Cost savings assumptions are shown in table 24.

Table 24 VOC for light and heavy vehicles with and without the project (CFAF/km) [52]

Savings from deviated merchandizes traffic	CFAF/ton
Solid	6852
Petroleum	3915
Cotton	5892

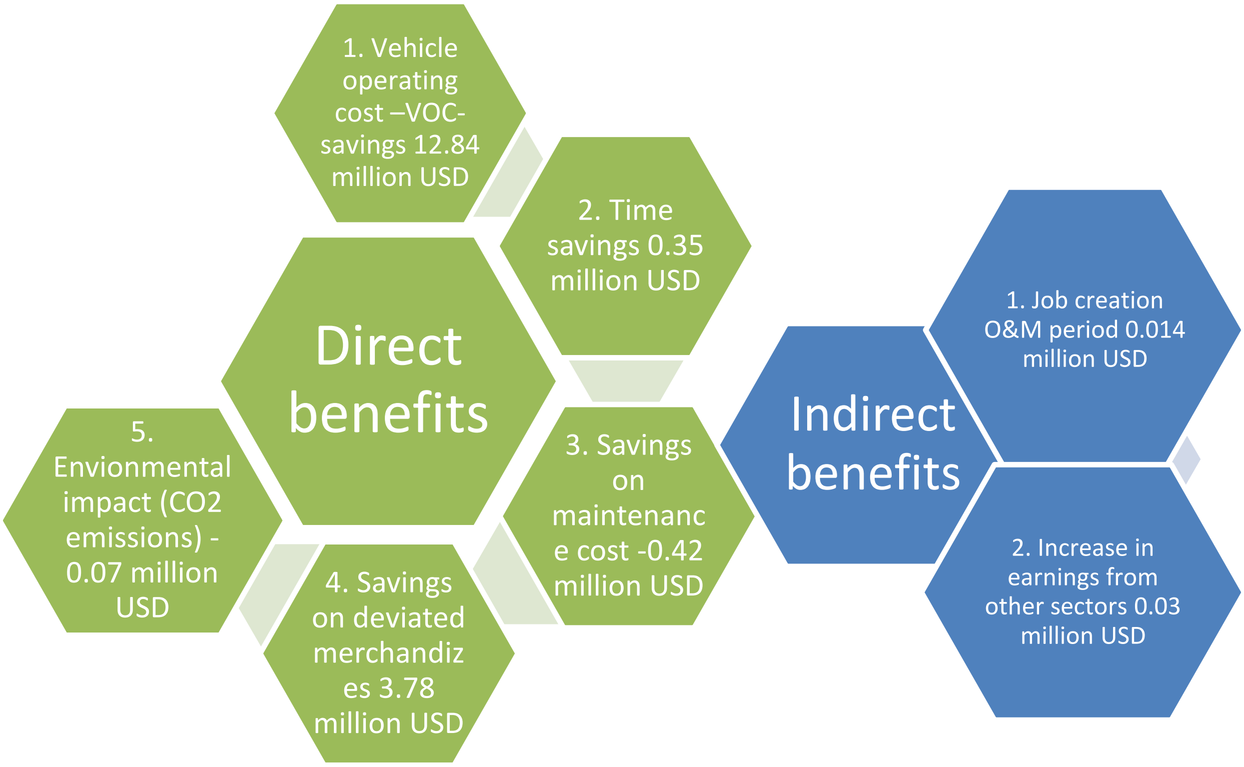
Results

In this section, benefits of the regional project were evaluated and not only IsDB components (calculation for IsDB is done in section 7)

Five different direct benefits were calculated for the project: 1) VOC savings with USD 12.83 million, 2) time savings with USD 0.34 million, 3) Savings on maintenance cost with a negative result of USD -0.42 million, 4) Savings on deviated merchandizes with USD 3.78 million. Indirect benefits applicable for this project was 1) job creation during operation and maintenance of the road 2) Increase in earnings from other sectors with USD 0.02 million and, 3) Environmental impact benefit (CO2 emissions) with USD -0.05 million, as presented in figure 25. All charts and economic cashflow are presented in Annex 2.

[52] Values taken from economic evaluation at appraisal.

Figure 25 Direct and indirect benefits calculated for Saraya-Kita Project (MUSD)



The realised investment cost of the project was USD 124.55 million. During the period 2010-2030, the project provides an economic return of USD 324 million and USD 160 million of economic costs (investment and O&M cost). The obtained EIRR was 17%.

With a 7.89% discount rate, the ENPV is USD 152 million and benefits/cost ratio of 2.

Table 25 Economic results from Saraya-Kita road project -7.89% discount rate-

Indicator	CFAF million	EUR million	USD million*
Total investment	73 345.63	111.81	124.55
Total Discounted Benefits	191 107.46	291.34	324.53
Total Discounted Costs	94 548.16	144.14	160.56
Benefits/Costs Ratio	2.02	2.02	2.02
EIRR	17%	17%	17%
ENPV	89 497.92	136.44	151.98

* Exchange rate to 17 may 2017 from http://www.xe.com/fr/currencyconverter/convert/?Amount=1&From=XOF&To=USD

When comparing the obtained results in the post-economic evaluation with the evaluation at appraisal, the economic return increased in almost 4% due mainly to an exponential increase in traffic and the inclusion of other benefits in the analysis despite the increase of 40% in investment cost.

Figure 26 shows discounted benefits, discounted costs and the accumulated ENPV resulting. Discounted benefits and costs presented are stable. The accumulated ENPV shows that the expected break-even of the project is in 2017.

Figure 26 Saraya-Kita road project

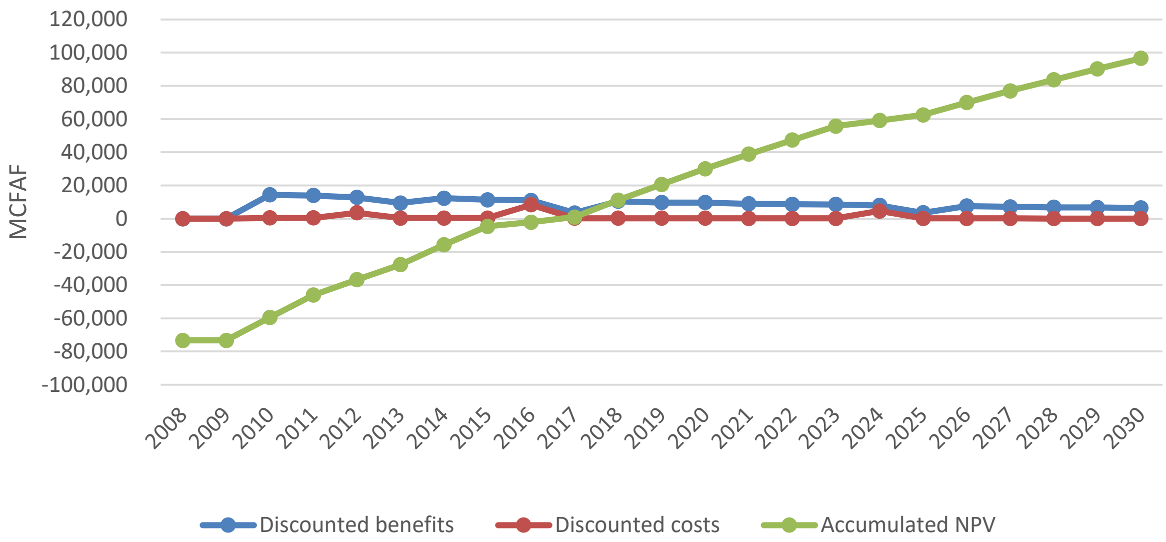
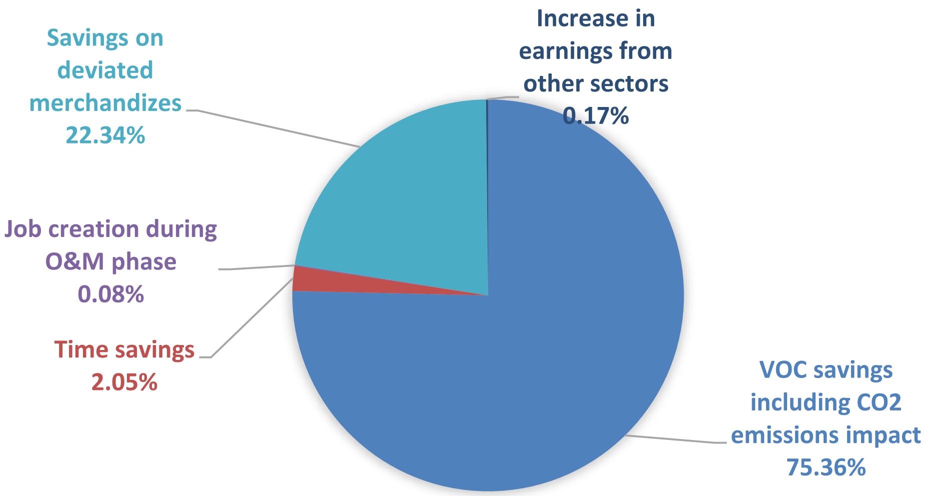


Figure 27 shows the expected positive benefits participation during the evaluation period for Saraya-Kita road project. 75% of the benefits come from VOC savings, 22% from savings on deviated merchandizes, and time savings with a 2% participation. Indirect benefits do not have a significant impact in earnings from other sectors nor CO2 emissions or job creation.

Figure 27 Expected positive benefits disaggregation in Saraya-Kita road project[53]



[53] CO2 emissions negative impact was included in VOC savings and savings on maintenance cost were excluded as its impact is negative.

VOC savings

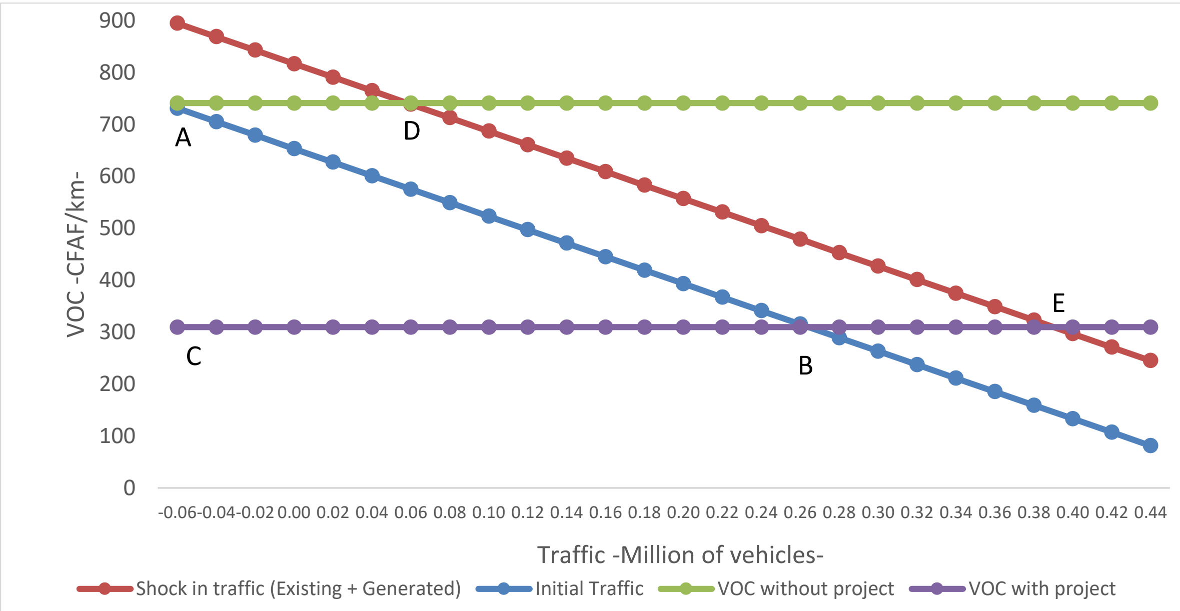
Figure 28 shows the impact of a change in VOC on traffic demand.

Two type of traffic on the new road can be distinguished: the existing traffic and generated/diverted one.

The first effect is VOC savings for existing traffic, where it is observed a change in traffic demand that goes from almost no traffic in the road (because of the use of the alternative road in through the north) to approximate 300,000 vehicles due to the decrease in VOC from 730 CFAF/km “without the project” scenario to 300 CFAF/km “with the project” one. Total benefits of VOC savings for existing traffic is the area ABC.

The second effect is VOC savings for generated/diverted traffic that takes place due to the shift of the demand curve due to an increase of approximately 600%[54] in its growth reaching a value of 15,532,212 instead of 13,535,426 vehicles due to the implementation of the project. In this last case, total benefits becomes the area ACDE.[55]

Figure 28 Impact in traffic demand due to a change in VOC

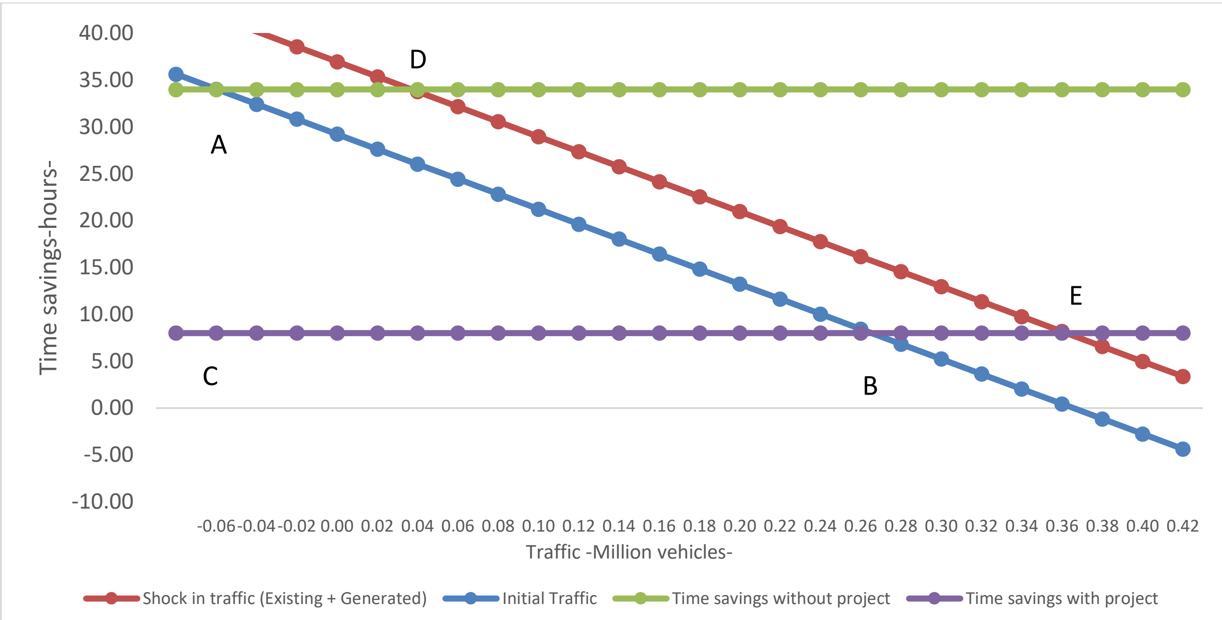


[54] Shift in demand in figure XX is only for illustrative purposes. Shift in demand in reality was six times the original one.
[55] Estimated values for illustrative purposes, as traffic demand and VOC are average values.

Time savings

Figure 29 illustrates the impact that time savings has in traffic demand. The first effect is time savings for existing traffic, where a decrease of 26 hours of travel time leads to a change in traffic demand from almost zero traffic to 260 million. Total benefits from time savings for existing traffic is ABC area. The second effect is time savings for generated/diverted traffic that takes place due to the shift of traffic demand with an increase of approximately 600%[56]. In this last case, total benefits become the area ACDE.[57]

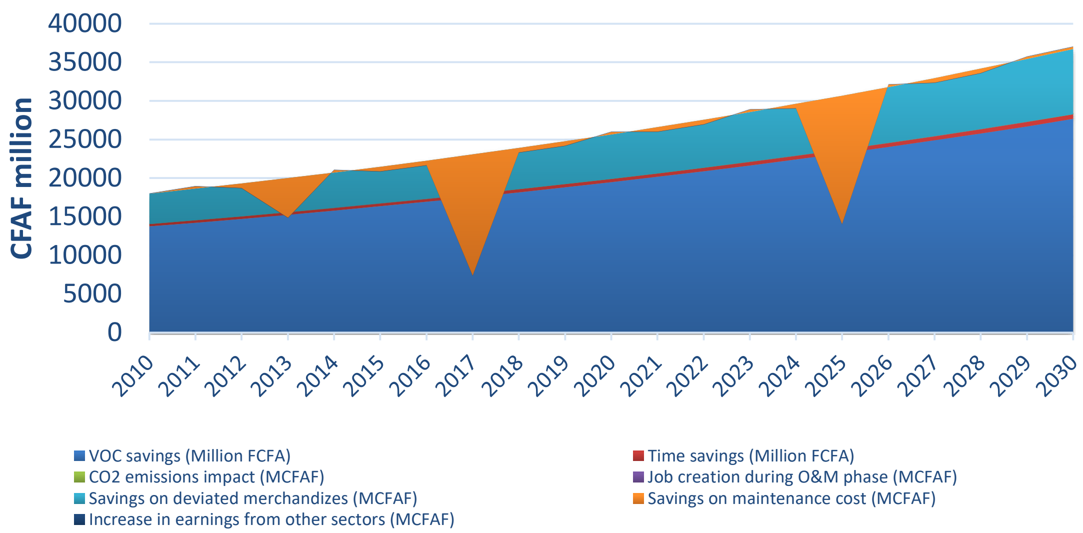
Figure 29 Impact in traffic demand due to a change in travel time



All benefits tend to increase with time; benefits from deviated merchandizes and time savings have a constant upwards trend, VOC exponentially increase due to the non-paved conditions of the road without the project. O&M of the road presents irregular behavior during specific periods of time, as a result of periodic maintenance planning of the road during its working life. The impact of O&M cost is negative due to the increase in maintenance cost considering the change from non-paved to paved condition of it. Finally, job creation and CO2 emission savings have a constant and negligible impact. See figure 30.

[56] Shift in demand in figure 8 is only for illustrative purposes. Shift in demand in reality was six times the original one.
[57] Estimated values for illustrative purposes, as traffic demand and time savings are average values. To calculate total time savings an occupancy rate of 3 was taken into consideration.

Figure 30 Benefits Evolution (classified by type) 2011-2030 Saraya-Kita



Sensitivity Analysis

As the main indicators of the study are ENPV and benefit/cost ratio, both indicators were calculated for different levels of discount rate to test the robustness of the developed study. In this case, the values of 6%, 10%, 12% and 14% were chosen based on regularly used discount rates by international institutions for developing countries when appraising infrastructure projects.

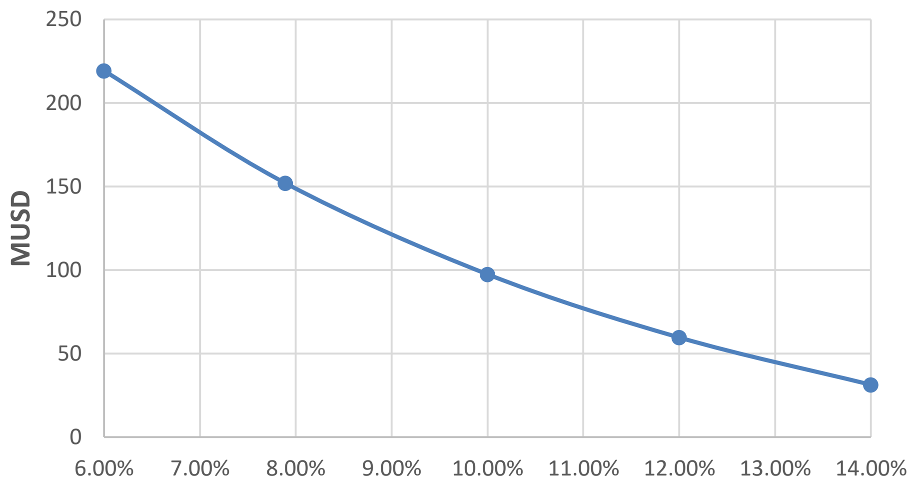
For a 12% discount rate, an ENPV of approximately USD 60 million obtained, 39% lower than the return with a discount rate of 10%. The impact in the B/C ratio is a reduction from 2.32 to 1.98, a 15% lower in comparison with the original discount rate.

Table 26 Sensitivity analysis for different discount rates 6% - 14% Saraya-Kita project

Sensitivity Analysis					
Discount rate	6.00%	**7.89%**	10.00%	12.00%	14.00%
ENPV (MSUD)	219	**152**	97	60	31
B/C ratio	2.4	**2.0**	1.7	1.4	1.2

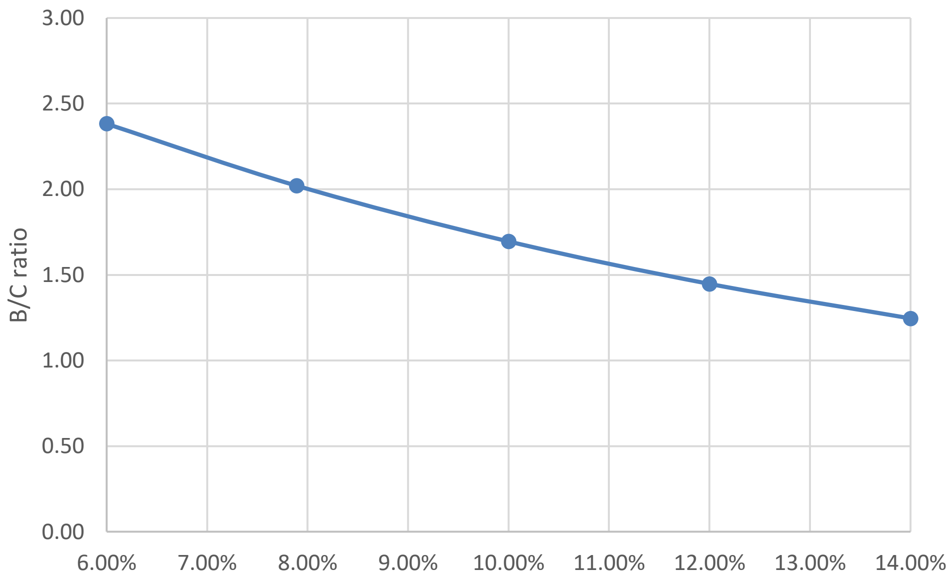
Figure 31 illustrates the sensitivity of ENPV to a change in discount rate. A change of 2.11% (from 7.89% to 10%) in the discount rate reduces the ENPV by approximately USD 55 million. Higher values of discount rates generate a lower impact in the ENPV, as the discount rate increases the impact decreases flattering the curve.

Figure 31 Sensitivity analysis ENPV – Saraya Kita road project



On the other hand, changes in discount rate has less impact in B/C ratio, for example, a change of 27% (from 7.89% to 10%) in the discount rate reduces the B/C ratio by 16% and the ENPV by 36%. Likewise, higher values of discount rates generate a lower impact in the B/C, in comparison to the impact generated in ENPV indicator. See figure 32.

Figure 32 Sensitivity analysis B/C ratio – Saraya Kita road project



When testing different traffic growth rates in generated traffic for the analysis the following results were found:

Table 27 Sensitivity Analysis for different growth rates in generated traffic Saraya-Kita regional road project

Changes in growth rates	**300%**	**400%**	**500%**	**600%**	**700%**
EIRR	14.13%	15.16%	16.16%	17.14%	18.04%
ENPV (MUSD)	148.55	171.90	195.24	219.18	241.93

As it observed, changes in different traffic growth rates in "generated traffic" have no significant impact in economic CBA indicators, what assures the consistency of the results and economic profitability of the project. Changes of 10% in growth rates generates impacts of 1 percentage point in EIRR and less than 16% approximately for the ENPV.

6 Conclusions

By the application of CBA, the economic evaluation of infrastructure projects offered a quantitative result of ex-post profitability. This ex-post analysis with partial realised data helps to reduce the uncertainty of key variables and provide a sounder measure.

Power generation expansion project in Mali presented an economic return of 29% besides the downsized of power capacity from 60MW to 48.6 MW, a lower demand growth during the evaluation period and finally the negative environmental impact of the power plant as a consequence of its technology. The high profitability of the power plant was driven mainly by the supply-demand gap reduction follow by fuel cost savings due to the substitution of diesel generators in the SI.

Economic return of Dakar Expressway in Senegal was 15%. The biggest contributor to economic benefits was accidents cost savings mainly driven by the road's high affluence, generated by its main function of being a connection point between the north part of the city and the airport.

Saraya-Kita regional project evaluation provided an economic return of 17% in comparison with the 13.9% calculated at appraisal. The main benefits contributor of this project was VOC savings follow by savings on deviated merchandises, despite the 40% increment in the investment cost and a delay of three years in the enter into operation of the project.

As shown in table 29, IsDB had a 97% of participation in power generation expansion in Mali representing a return of USD 424.60 million. For road projects, IsDB participation had been lower with a 64% for Dakar Expressway and 10% for Saraya-Kita Regional Road one. The ENPV obtained for Dakar

Expressway was USD 40 million and USD 89 million for Saraya-Kita. Overall, total economic return from IsDB participation corresponds to USD 548 million.

Table 28 Global economic return from IsDB participation

IsDB participation	IsDB participation	Total ENPV (EUR million)	ENPV for IsDB		
			CFAF million	EUR million	USD million
Power Generation Expansion (MLI0092) 6.23% discount rate	97%	449	284 292	433	483
Upgrading of Dakar Expressway (SEN0096) 8.27% discount rate	64%	62	25 932	40	44
Saraya-Kita Regional Road Project (MLI0079 and SEN0080) 7.89% discount rate	12%	136	12 284	19	21
Total		**198**	**322 508**	**492**	**548**

The participation of IsDB provided important economic benefits in different sectors of Mali´s and Senegal's economies. Real economic returns might be underestimated, as some benefits could not be calculated due to missing data. A conservative perspective from the consultant was taken into consideration when determining the quantitative assumptions of the model to obtain a more realistic approach.

7 Further work

Previous analysis can be improved by developing the calculation with real actual data for some key variables that were not possible to include due to missing data from the country's agencies in the respective countries and IsDB. Implementing a more detail analysis will provide more accurate results about the feasibility and profitability of the already implemented projects and can be used as a benchmarking for new public projects of similar projects considered within its development plans.

It is recommendable to complement the study with other methodology like CEA or CMA to capture the economic return of non-quantitative variables such as the value of life, of time, etc. Hence, a more accurate value, that the population, government and involved institutions gives to this type of variables, will be estimated.

Incorporate the developed methodology for *ex ante* evaluation in order to have a more consistent and complete analysis of decision making taken by the involved authorities.

Introduce econometric techniques and tools for different inputs like demand forecasting of traffic and electricity consumption will improve the accuracy of the present methodology and reduce the uncertainty of key variables.

8 References

ADB, 2014. *Economic Internal Rate of Return.* [Online] Available at: https://www.adb.org/sites/default/files/page/149401/estimation-eirr-2014.pdf

AFD, 2015. *Mali country profile.* [Online] Available at: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Profil_ER_Mal_Web_light.pdf
[Accessed 2017].

AFD, 2016. *Mali Economic Outlook.* [Online] Available at: https://www.afdb.org/en/countries/west-africa/mali/mali-economic-outlook/
[Accessed 2017].

African Development Bank Group, 2012. *Infrastructure Investment and Economic Growth in South Africa.* [Online] Available at: http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Working%20Paper%20160%20-%20Infrastructure%20Investment%20and%20Economic%20Growth%20in%20South%20Africa%20A%20Granger%20Causality%20Analysis.pdf

African Development Fund , 2014. *TRANSPORT SECTOR SUPPORT PROJECT.* [Online] Available at: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Senegal_-_Transport_Sector_Support_Project_-_Rehabilitation_of_the_Dinguiraye_-_Nioro_-_Keur_Ayib_Road_-_Appraisal_Report.pdf
[Accessed 2017].

AICD, 2011. *Mali's Infrastructure: A continental's perspective.* [Online] Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/3452/WPS5688.pdf?sequence=1&isAllowed=y
[Accessed 2017].

Asian Development Bank, 2013. *Cost-benefit analysis for development A practical Guide,* Philippines: s.n.

CEEU, 2012. *Guide to economic appraisal: Carrying out a cost benefit analysis.* [Online] Available at: http://publicspendingcode.per.gov.ie/wp-content/uploads/2012/08/D03-Guide-to-economic-appraisal-CBA-16-July.pdf
[Accessed 2017].

Cervero, R., 2011. *Beyond Travel Time savings.* [Online] Available at: http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1239112757744/5997693-1294344242332/Traveltimesaving.pdf

Damodaran, A., s.d. *Discount Rates.* [Online] Available at: http://people.stern.nyu.edu/adamodar/pdfiles/eqnotes/dcfrates.pdf

Deloitte, 2017. *Invest in Senegal: A competitive investment destination in West Africa.* [Online] Available at: file:///C:/Users/dmenendezarchila/Downloads/za_ASG_Country%20Reports_Senegal_Repro.pdf
[Accessed 2017].

Department for Communities and Local Government: London, 2009. *Multi-criteria analysis: a manual.* [Online]
Available at: http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf
[Accessed 2017].

DTR, 2014. *Etude sur les couts et conditions d'exploitation des vehicules de transport public de voyageurs au Senegal pour une tarification optimale,* Senegal: Ministere des infrastructures, des tansports terrestres et du desenclavement.

Economics e-journal, 2011. *Regional and Sectoral Estimates of the Social Cost of Carbon: An Application of FUND.* [Online] Available at: http://www.economics-ejournal.org/economics/discussionpapers/2011-18/file
[Accessed 2017].

EPA, 2016. *Social cost of carbon.* [Online] Available at: https://www.epa.gov/sites/production/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf
[Accessed 2017].

EPA, s.d. *Greenhouse gas emissions from a Typical Passenger Vehicle.* [Online] Available at: https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle-0
[Accessed 2017].

European Commission, 1997. *Guide to Cost-Benefit Analysis of Major Projects.* [Online] Available at: http://ec.europa.eu/regional_policy/sources/docgener/guides/cost/pdf/3_full_en.pdf
[Accessed 2016].

European Commission, 2014. *Guide to Cost-Benefit Analysis of Investment Projects.* [Online] Available at: http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf
[Accessed 2017].

European Investment Bank, 2013. *The Economic Appraisal of Investment Projects at the EIB.* [Online] Available at: http://www.eib.org/attachments/thematic/economic_appraisal_of_investment_projects_en.pdf
[Accessed 2017].

Garber, A. & Phelps, C. E., 1997. *Economic fooundations of cost-effectiveness analysis.* [Online] Available at: http://ac.els-cdn.com/S0167629696005061/1-s2.0-S0167629696005061-main.pdf?_tid=44537442-564a-11e7-8e68-00000aacb361&acdnat=1498026443_c5f0dc12a24550ce00ab5dac2adf1433

GOE, 2016. Enhancing Trade and Integration through Saraya-Kita Road. *GOED K-Series.*

Investopedia , 2017. *The International Fisher Effect: An Introduction.* [Online] Available at: http://www.investopedia.com/articles/economics/10/international-fisher-effect.asp

IRENA, 2012. *Prospects for the African Power Sector.* [Online] Available at: https://www.irena.org/DocumentDownloads/Publications/Prospects_for_the_African_PowerSector.pdf
[Accessed 2016].

IRENA, 2013. *Renewable Energy and Jobs.* [Online] Available at: http://www.irena.org/rejobs.pdf
[Accessed 2016].

IsDB, 2003. *Annexes of Economic Apparaisal Saraya-Kita regional project,* s.l.: s.n.

IsDB, 2007. *Report and Recommendation of the President of the IDB on a propoosed combination of loan and lease financing for the power generation expansion project -MALI,* Djeddah, Saudi Arabia: s.n.

IsDB, 2008. *PCR Kita Sekokoto Section,* Bamako: s.n.

IsDB, 2008. *Proposed Supplementary Istisna'a financing for the upgrading of the Dakar Expressway (VDN) project in Senegal ,* Senegal: s.n.

IsDB, 2012. *Acquisition of 60 MW Power Plant Project in Dakar Senegal (SE0100) ,* Dakar: s.n.

IsDB, 2014. *Connecting West Africa: The Trans-Sahelian Highway.* [Online] Available at: http://www.isdb.org/irj/go/km/docs/documents/IDBDevelopments/Attachments/Projects/s21_WestAfrica.pdf
[Accessed 2017].

IsDB, 2015. *Liste des Informations requises pour la mission de Post-Evaluation de la BID pour le Projet de Mise à Niveau de la VDN première section,* Senegal: s.n.

IsDB, 2015. *Project Completion Report on the Power GenertionExpansion Project- Mali,* Soudi Arabia: IsDB.

IsDB, 2017. *Islamic Development Bank.* [Online] Available at: http://www.isdb.org/irj/portal/anonymous?NavigationTarget=navurl://fe68ebaa6541fcf4c62134ea6d389185
[Accessed 2017].

Jones, H., Moura, F. & Domingos, T., 2014. *Transport infrastructure project evaluation using cost-benefit analysis.* [Online] Available at: http://ac.els-cdn.com/S1877042814000743/1-s2.0-S1877042814000743-

main.pdf?_tid=a62a9632-b636-11e6-ba83-00000aacb35f&acdnat=1480425831_466ff04af76b99b5e928845695e6d516
[Accessed 2016].

Mali´s National Authorities, 2017. *La liste de donnees necessaires pour l'evaluation de la rentabilité economique de la centrale de balingue phase I,* Mali: s.n.

Ministere de l'energie, 2015. *Etude de la demande et du plan directeur d'investissements optimaux pour le secteur de l'électricité au Mali,* Mali: Artelia.

No author, 2016. *Internal Rate of Return IRR and Modified IRR Explained.* [Online]
Available at: https://www.business-case-analysis.com/internal-rate-of-return.html

NSW Government, 2013. *Principles and guidelines for Economic Appraisal of Transport Investment and Initiatives.* [Online]
Available at: http://www.transport.nsw.gov.au/sites/default/files/b2b/publications/tfnsw-principles-and-guidelines-for-economic-appraisal-of-transport-initiatives.pdf
[Accessed 2016].

Oseni, M. O., No year. *Power Outages and the Costs of Unsupplied Electricity.* [Online]
Available at: https://pdfs.semanticscholar.org/ced6/6a3eb2d00a416501131cbbbf07483248c2f1.pdf

Quinet, É., 2013. *Cost benefit assessment of public investment,* Paris : Commissariat géneral à la stratégie et à la prospective .

Rus, G. d., 2016. *The economic evaluation of infrastructure investment,* Madrid: s.n.

SEN, 2017. *Accidents 2008-2015,* Dakar: s.n.

Senegal's Road National Authorities, 2017. *Réponses Questionnaire VDN Senegal,* Dakar: s.n.

Simous, A., 2014. *Observatory of Economic Complexities.* [Online]
Available at: http://atlas.media.mit.edu/en/profile/country/civ/

The centre for spatial economics, 2015. *The economic benefits of public infrastructure, spending in Canada.* [Online]
Available at: https://d3n8a8pro7vhmx.cloudfront.net/broadbent/pages/4555/attachments/original/1441907687/The_Economic_Benefits_of_Public_Infrastructure_Spending_in_Canada.pdf?1441907687

World Bank, 2017. *Mali country overview.* [Online]
Available at: http://www.worldbank.org/en/country/mali/overview
[Accessed2017].

Zhuang, J., Liang, Z., Lin, T. & De Guzman, F., 2007. *Theory and Practice in the Choice of Social Discount Rate: for Cost-Benefit Analysis: A Survey.* [Online]
Available at: https://www.adb.org/sites/default/files/publication/28360/wp094.pdf
[Accessed 2017].

Zhuang, J., Liang, Z., Lin, T. & De Guzman, F., 2007. *Theory and Practice in the Choiceof social discount rate for cost-benefit analysis: A survey.* [Online]
Available at: https://www.adb.org/sites/default/files/publication/28360/wp094.pdf
[Accessed 2017].

ANNEX 1

Additional methodology for sector analysis

1 Economic Valuation of Network Electricity Projects[58]

1.1.1 Framework for the evaluation of Electricity Network Infrastructure

Investments in Network infrastructure can be of three kinds:

- Projects in Electricity transmission networks (and/or associated transformer stations)
- Projects in Electricity distribution networks (and/or associated transformer stations)
- Projects in Electricity interconnectors

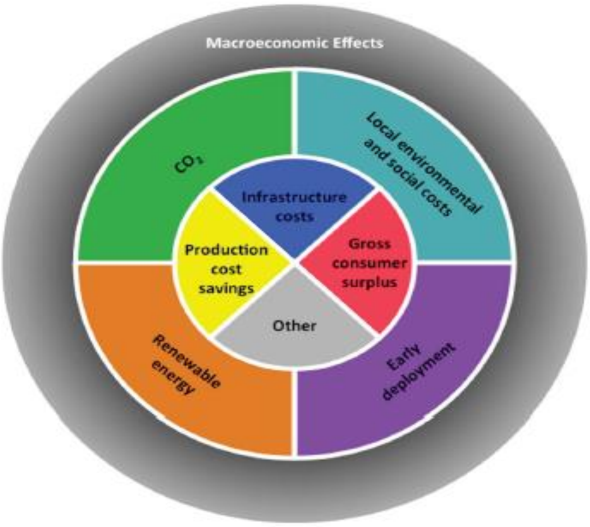
Three effects should be valued for electricity infrastructure projects of IsDB:

1. **Infrastructure costs**
   Infrastructure costs include capital costs of construction (capex) as well as operation and maintenance costs (opex) over the lifetime of the infrastructure.

2. **Production cost savings**
   Production cost savings refers to the benefits associated with a more efficient dispatching and a more efficient use of ancillary and balancing services, consisting of reduction in variable costs of production (opex) and the avoided investment cost (capex).
3. **Gross consumer surplus**

   Gross consumer surplus refers to the benefits resulting from changes in consumption volume (that can be evaluated with the willingness to pay of consumers).

[58] (European Investment Bank, 2013)



Source: (THINK, 2013)

1.1.2 Net benefits of the investment

The evaluation of electricity network infrastructure projects financed by IsDB in Mali and Senegal will focus on the following:

- Supply of incremental electricity demand (capacity extension) or maintaining the ability to supply (capacity refurbishment).
- Improvement or maintenance of the quality of supply (avoidance of power interruptions).
- Reduction in losses
- Connection of new generation with load centers or reinforcements thereof (high voltage transmission)
- Enabling the exchange in power between different electricity systems/markets and associated benefits (interconnectors).
- Increasing the security of supply in the short and medium term of the system by a lower requirement of ancillary services due to the reinforcement of the network.

For distribution networks, only:

- Enabling the active participation in the system of distribution network with smart grids that allows the participation of the demand in the quality of the service like batteries, electric vehicles, smart meters, etc.

The typical average economic life considered for investments of this type is 25 years.

Table 29 Benefits calculation of Network Electricity Projects

Number	Direct Benefits	Description	Economic Evaluation
Additional methodology for direct benefit No. 1	**Value supply – demand gap reduction or maintaining the ability to supply (SD)**	Concerns the incremental consumption realized.	$SD = \sum_{y=1}^{n}[(S_o - D_o) - (S_f - D_f)]\ x\ VOLL$ Where, So = Supply without project Do = Demand without project Sf = Supply with project Df = Demand with project VOLL = Value of Lost Load $VOLL = \frac{G}{\pi} + v$ Where, G = Marginal generator capacity π = Outage time in minutes v = Variable cost of marginal unit (Oseni, No year)
Additional direct benefit No. 2	**Value of reduction in network losses (L)**	Based on the planned reduction of network losses enabled by the investments, valued at the saved average cost in power generation (plus transmission cost if applicable).	$L = [E_f x\ C_f - E_o x\ C_o]$ Where, E_f = Energy lost in transmission network with the project in MWh E_o = Energy lost in transmission network without the project in MWh c_f = Average cost of energy in the system after the project in CFAF/MWh c_o = Average cost of energy in the system before the project in CFAF/MWh
Additional direct benefit No. 3	**Exchange of power between different electricity systems/markets.**	Measured by the capacity of interconnection to other systems in units of energy and the increment of security of supply measure by lowering the security criteria for quality of service.	

Additional direct benefit No. 4	**Integration of renewable energy**	The integration of renewable electricity generation capacity through network extensions or smart grids can be valued at the estimated cost of curtailment of the planned renewable electricity generation capacity (a 20% reduction in load factor of wind power capacity could cost around EUR15/MWh), plus any cost of counter trading undertaken by the TSO to avoid overloading of saturated transmission lines.

2 Power generation projects

Table 30 Benefits calculation of Power Generation Projects

Number	Direct Benefits	Description	Economic Evaluation * Draft
Additional direct benefit No. 1	**Supply-Demand gap reduction:** Reduction value of the supply – demand gap or maintaining the ability to supply (SD)[59]	Concerns the incremental consumption realized.	$SD = [(S_o - D_o) - (S_f - D_f)]\ x\ VOLL$ Where, So = Supply without project Do = Demand without project Sf = Supply with project Df = Demand with project VOLL = Value of Lost Load *VOLL will be developed in direct benefit No. 2
Additional direct benefit No. 2	**Security of supply:** Value of improvement or preservation of the security of supply (avoidance of	Is evaluated on the planned reduction of quality of service indicators calculated by each regulatory framework that can include the CML (Customer Minutes Lost) and the resulting reduction of the unserved energy enabled by the investments, valued at the	$VOLL = \frac{G}{\pi} + v$ Where, G = Marginal generator capacity π = Outage time in minutes v = Variable cost of marginal unit (Oseni, No year)

[59] Review with page 281 of cost-benefit analysis development.

	power interruptions);[60]	estimated social cost of power cuts –SCP- (energy not served – estimated at the ratio of GDP and electricity consumption in the given area). It can also be measure by the estimation of the "value of lost load" (VOLL): The indicator is the value that represents a customer's willingness to pay for reliable electricity service. It is usually measure in monetary units per unit of energy (USD/MWH). Estimation of non-satisfied demand: Is the amount of demand that is not served due to the lack of generation capacity in the system. It is usually measure in units of power or energy (MW/MWH).	$CML = \frac{\sum CIM}{\sum TCS}$ Where, CIM = Customer interruption duration in minutes TCS = Total number of customers served $SCP = \frac{GDP}{ED}$ Where, GDP = Gross Domestic Product ED = Electricity Demand $ENS = \sum (P_i x\ t)$ Where, ENS = Energy Not Served P = Power interrupted t = Time duration of fault
Additional direct benefit No. 3	Value of the increase in energy efficiency (EE)	Measure by the efficiency of the power plant due to technology changes in the generation mix. It is measure in unit of primary energy/unit of electricity produced.	$EE = [p_f x\ EC_f - p_o x\ EC_o]$*P Where, p_f = production factor with the project EC_f = Production volume of the project p_o = Production factor of current plants without the project EC_o = Production volume of the project P = National Electricity Price of Electricity
Additional	Benefit from the reduction of	Is the measure of the impact in electricity prices due to the increase in the capacity that	$P = [p_f x\ EC_f - p_o x\ EC_o]$ Where,

[60] Review with page 287 of cost-benefit analysis development.

direct benefit No. 4	prices (P) if applicable	leads towards price reductions (depending on the type of electricity system, market or centralized system, and price fixation methodology)	p_f = Energy price after the project in CFAF/MWh EC_f = Total Energy consumed after the project in MWh p_O = Energy price before the project in CFAF/MWh EC_o = Total Energy consumed before the project in MWh
Additional direct benefit No. 5	Benefit from the Reduction of imports of electricity or primary energy (M) if applicable	It is measure by the reduction in primary sources to produce electricity or substitution cost of renewable energy projects.	$M = [C_i - C_f] * XR_f$ Where, C_i = Production cost of imports C_f = Production cost of the project XR_f = Reduction in imports due to local production

3 Economic Valuation of road projects

Table 31 Benefits calculation of road projects

Number	Direct Benefits	Description	Economic Evaluation * Draft
Additional methodology for direct benefit No. 1	Total value of reducing the number of accidents. (As) 3. Value of reduction in Non-fatal accidents (A_N), which can be classified in severe (S_{AN}) and slight injuries (L_{AN}) 4. Value of reduction in	Evaluation of direct costs: 3. Non-fatal accidents: total cost of hospital treatment and cost of income lost due to possible absence from work or at 15 % and 18 % of VOSL production losses for, respectively, severe and slight injuries. (European Commission, 2014) Evaluation of indirect costs:	$A_s = \sum_{y=1}^{n} (A_{Ntc} + A_{Fc})$ Where, A_s = Benefits from total accidents cost reduction A_N = Benefits from total Non fatal accidents cost reduction. A_F = Benefits from total fatal accidents cost reduction. y = evaluation years of life duration of the project. c = Type of accident cost (direct or indirect) t = Type of accident (severe or slight) **Direct cost** Non-fatal accidents: $A_N = \sum_{y=1}^{n} [a_f * c_h - a_o * c_h] \text{x N}$ Where, a_f = Non fatal accidents rate after the project

	Fatal accidents (A_F) Accidents are composed by two types of cost: Direct costs: All directly related costs like medical rehabilitation, administrative, court, insurances, etc. Indirect costs: consist of the net production loss to society.	2. Fatal accidents: value of human life quantified based on average income and life expectancy. (European Commission, 1997) It is preferable to use stated preference or revealed preference techniques based on the concepts of willingness to pay/willingness to accept. Another alternative is to use Human Capital Approach based on the calculation of: Value of Statistical Life (VOSL): Discounted sum of the individual's future (marginal) contributions to the social product, which corresponds to future labour income, considering that the wage is equal to the value marginal product. 3. Non-Fatal Accidents: 13 % of VOSL for severe injuries and 1 % for light	a_o = Non fatal accidents rate before the project c_h = average cost of hospitalisation per habitant N = Total number of users y = evaluation years of life duration of the project. **Indirect cost** Fatal accidents: $$1)\ A_F = \sum_{y=1}^{n} [(b_f - b_o) x\ (l - a)] x\ i$$ Where, bf = Number of fatal accidents after the project b_o = Number of fatal accidents before the project l = life expectancy a = average age of death i = average income per habitant y = evaluation years of life duration of the project. or, $$2)\ A_F = \sum_{y=1}^{n} (b_f - b_o) x\ VOSL$$ $$VOSL = \sum_{t}^{T} \frac{w_t}{(1+i)^t}$$ Where, y = evaluation years of life duration of the project. bf = Number of fatal accidents after the project b_o = Number of fatal accidents before the project T = Remaining lifetime t = Average age of death i = social discount rate w = average income per habitant Non- Fatal accidents: Measure as a percentage of VOSL describe in previous column.

		ones. (European Commission, 2014)	

ANNEX 2

Results of Economic Evaluation

3.1 Power Generation Expansion (MLI0092)

Economic Post-Evaluation
Power Generation Expansion (MLI0092)

Description	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Discount Rate	**9%**																		
	100%	92%	85%	78%	72%	66%	61%	56%	51%	47%	43%	40%	37%	34%	31%	29%	26%	24%	22%
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Investment																			
Equipment	-29624																		
Consultancy	-323																		
Support at Management Project Unit	-105																		
Audit	-16																		
Revenues (MFCFA)	**0**	**0**	**0**	**63**	**9683**	**17692**	**17664**	**22834**	**29206**	**37353**	**38108**	**38485**	**39239**	**39994**	**40371**	**41126**	**41503**	**42258**	**43012**
Energy production GWh				1	105	188	186	235	298	377	377	377	377	377	377	377	377	377	377
Average Tariff (FCFA/kWh)	87	88	90	91	92	94	95	97	98	99	101	102	104	106	107	109	110	112	114
Costs	**0**	**0**	**7708**	**13212**	**9574**	**23124**	**23094**	**23436**	**24429**	**26394**	**26729**	**12734**	**25581**	**27764**	**28120**	**28481**	**28847**	**29219**	**29596**
Total production cost (MFCA)	0	0	0	38	5637	10820	10683	13350	17286	22977	23312	23652	23997	24347	24703	25064	25430	25802	26179
Overcost due to usage of diesel generation MFCA	0	0	7708	13175	3936	12304	12411	10086	7143	3417	3417	-10918	1584	3417	3417	3417	3417	3417	3417
Annual Operating flow	**0**	**0**	**-7708**	**-13149**	**109**	**-5431**	**-5430**	**-603**	**4777**	**10959**	**11379**	**25751**	**13658**	**12230**	**12252**	**12645**	**12656**	**13039**	**13417**
Total Benefits	**0**	**0**	**0**	**33597**	**2315**	**-3246**	**497**	**5077**	**11430**	**17135**	**30404**	**17135**	**17135**	**143085**	**42361**	**173261**	**178761**	**61061**	**97911**
Benefits from security of supply reduction MFCA			**0**	**33385**	**-2145**	**-11605**	**-7755**	**-5500**	**-2090**	**0**	**13269**	**0**	**0**	**125950**	**25300**	**156200**	**161700**	**44000**	**80850**
ENS without the project (GWh)	0	0	0	64	0	0	0	0	0	0	24	0	0	505	423	770	716	561	1040
ENS with the project (GWh)			0	3	4	21	14	10	4	0	0	0	0	276	377	486	422	481	893
CENS (conservative) (MFCA/GWh)			550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550
Fuel cost savings MFCFA			**0**	**32**	**4947**	**8846**	**8739**	**11064**	**14007**	**17733**	**17733**	**17733**	**17733**	**17733**	**17733**	**17733**	**17733**	**17733**	**17733**
CO2 emissions price at 3% discount rate per metr	-		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO2 emissions in tons					83008	83008	83008	83008	83008	83008	83008	83008	83008	83008	83008	83008	83008	83008	83008
CO2 emissions impact MFCFA					**-667**	**-667**	**-667**	**-667**	**-667**	**-778**	**-778**	**-778**	**-778**	**-778**	**-852**	**-852**	**-852**	**-852**	**-852**
Job creation	**0**	**0**	**0**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**	**180**
Job creation in construction phase in MFCFA																			
Job creation in O&M in MCFA	0			180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
Total annual flow	**-30068**	**0**	**-7708**	**20448**	**2424**	**-8677**	**-4933**	**4474**	**16208**	**28094**	**41782**	**42886**	**30794**	**155315**	**54613**	**185906**	**191417**	**74100**	**111328**
ENPV	**-30068**	**0**	**-6524**	**15921**	**1736**	**-5718**	**-2991**	**2495**	**8315**	**13260**	**18143**	**17131**	**11316**	**52508**	**16986**	**53193**	**50386**	**17944**	**24801**
Accumulated ENPV	**-30068**	**-30068**	**-36592**	**-20671**	**-18935**	**-24653**	**-27643**	**-25148**	**-16833**	**-3573**	**14570**	**31701**	**43017**	**95526**	**112511**	**165704**	**216090**	**234034**	**258835**

EIIR	**30%**

Description	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Discounted Benefits	0	0	0	26208	8594	9520	11009	15566	20849	25718	29749	22218	20717	61895	25731	61342	57979	25019	31394
Discounted Costs	30068	0	6524	10287	6380	14798	13596	12698	12191	12091	11268	4776	9115	9123	8481	7905	7369	6869	6403

Economic Evaluation at Appraisal with updated data Source: (IsDB, 2007)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Investissements		*29 624*																	
. Etudes, supervision, audits		*323*																	
. Fournitures, montage		*105*																	
. Imprévus (13 %)	*0*	16																	
Total Investissements (MCFAF)	**0**	**30 068**	**0**																
Exploitation																			
Charges																			
Production nouveaux groupes (GWh)	0.0	0.0	164.0	281.0	189.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0
Cons. spécif groupes (g/kWh)	200	200	200	200	200	200	200	200	200	200	200	200	205	205	205	205	205	205	205
Taux d'inflation	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Prix HT du Fuel lourd (CFAF/l)	200	203	206	209	212	215	219	222	225	229	232	236	239	243	246	250	254	258	261
Consom. combustible (MCFAF)	0	0	7 114	12 372	8 446	8 618	8 748	8 879	9 012	9 147	9 284	9 424	9 804	9 951	10 100	10 252	10 406	10 562	10 720
Cons.spécif lubrifiants (g/kWh)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Prix HT des lubrifiants (CFAF/l)	1 000	1015	1030	1046	1061	1077	1093	1110	1126	1143	1161	1178	1196	1214	1232	1250	1269	1288	1307
Consom. Lubrifiants (MCFAF)	0	0	178	309	211	215	219	222	225	229	232	236	239	243	246	250	254	258	261
Frais d'exploit. et maintenance	0	0	281	482	324	326	326	326	326	326	326	326	326	326	326	326	326	326	326
Total des charges (MCFAF)	***0***	***0***	***7 573***	***13 164***	***8 982***	***9 160***	***9 292***	***9 427***	***9 563***	***9 702***	***9 843***	***9 985***	***10 369***	***10 520***	***10 673***	***10 828***	***10 986***	***11 145***	***11 308***
Produits																			
Rendement de réseau	77%	78%	78%	79%	79%	80%	80%	81%	81%	82%	82%	83%	83%	84%	84%	85%	85%	85%	85%
Energie supplémentaire livrée (GWh)	0	0	0	125	57	92	167	253	97	253	156	0	0	192	39	240	250	68	125
Tarif moyen (CFAF/kWh)	87	88	90	91	92	94	95	97	98	99	101	102	104	106	107	109	110	112	114
Ventes supplémentaires (M. CFAF)	0	0	0	11 375	5 286	8 584	15 933	24 449	9 463	25 176	15 758	0	0	20 222	4 148	26 146	27 589	7 620	14 212
Economies (groupes existants)			8 003	6 043	6 778	6 121	-25	-6 404	5 523	-6 348	0	11 860	13 844	-1 357	10 961	-5 161	-5 934	6 711	2 663
Total produits (M. CFAF)	***0***	***0***	***8 003***	***17 418***	***12 064***	***14 705***	***15 908***	***18 045***	***14 986***	***18 828***	***15 758***	***11 860***	***13 844***	***18 866***	***15 109***	***20 984***	***21 656***	***14 331***	***16 874***
Flux annuels d'exploitation (MCFAF)	**0**	**0**	**430**	**4 255**	**3 082**	**5 545**	**6 616**	**8 618**	**5 423**	**9 126**	**5 915**	**1 875**	**3 475**	**8 346**	**4 436**	**10 156**	**10 670**	**3 186**	**5 567**
Valeur résiduelle des invest.																			**922**
Energie non livrée sans le Projet (GWh)	0.0	0.0	0.0	0.0	159.0	72.3	115.0	209.0	314.0	119.0	310.0	190.0	0.0	0.0	229.0	46.0	284.0	294.0	80.0
Coût de défaillance (CFAF/kWh)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Pertes économiques évitées (MCFAF)	**0**	**0**	**0**	**0**	**1 590**	**723**	**1 150**	**2 090**	**3 140**	**1 190**	**3 100**	**1 900**	**0**	**0**	**2 290**	**460**	**2 840**	**2 940**	**800**
Pertes économiques évitées (MCFAF) actualisées pour 45 MW	**0**	**0**	**0**	**0**	**1 590**	**723**	**1 150**	**2 090**	**3 140**	**1 190**	**3 100**	**-700**	**0**	**0**	**2 290**	**460**	**2 840**	**2 940**	**-1 800**
Flux nets annuels (M. CFAF)	**0**	**-30 068**	**430**	**4 255**	**4 672**	**6 269**	**7 766**	**10 708**	**8 563**	**10 316**	**9 015**	**1 175**	**3 475**	**8 346**	**6 726**	**10 616**	**13 510**	**6 126**	**4 689**

Taux de rentabilité	**TRI =**	**17.9%**

Taux d'actualisation	**3.0%**	**4.0%**	**5.0%**
VAN	**54 717**	**46 808**	**39 934**

Prix de vente moyen 2006:	**87**	**CFAF/kWh**
Coût de défaillance :	**10**	**CFAF/kWh**

3.2 Upgrading of Dakar Expressway (SEN0096)

Description	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Discount Rate	**8,27%**																							
	100%	92%	85%	79%	73%	67%	62%	57%	53%	49%	45%	42%	39%	36%	33%	30%	28%	26%	24%	22%	20%	19%	17%	16%
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Investment																								
Civil works (roads and sanitation) 2007	-8127																							
Civil works (Interchanges) 2007	-11830																							
Complementary civil works 2008		-6256																						
Civil works (Pasarelles) 2009			-2897																					
Control and surveillance 2009			-603																					
Traffic forecasting (Million Vehicles)	**5**	**5**	**5**	**5**	**7**	**7**	**8**	**8**	**8**	**9**	**9**	**9**	**9**	**10**	**10**	**11**	**11**	**11**	**12**	**12**	**12**	**13**	**13**	**14**
Average yearly traffic forecasted without the project (M	5	5	5	5	6	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	10	10	10	11
Average Generated traffic (Million vehicles)	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
Costs	**0**	**0**	**0**	**0**	**31**	**29**	**29**	**32**	**35**	**39**	**43**	**47**	**51**	**57**	**62**	**68**	**75**	**83**	**91**	**100**	**110**	**121**	**133**	**147**
Operation and maintenance of the road (Million		0	0	0	31	29	29	32	35	39	43	47	51	57	62	68	75	83	91	100	110	121	133	147
Residual value of investment																								
Annual Operating Flow	**-19957**	**-6256**	**-3500**	**0**	**3855**	**4862**	**6161**	**6906**	**7338**	**7575**	**7819**	**8071**	**8333**	**8599**	**8878**	**9166**	**9464**	**9772**	**10088**	**10417**	**10757**	**11108**	**11470**	**11845**
Total Benefits	**0**	**0**	**0**	**0**	**3886**	**4891**	**6190**	**6938**	**7374**	**7613**	**7861**	**8118**	**8384**	**8656**	**8940**	**9235**	**9540**	**9855**	**10179**	**10517**	**10867**	**11229**	**11604**	**11991**
VOC savings (Million FCFA)	**0**	**0**	**0**	**0**	**457**	**473**	**489**	**506**	**524**	**542**	**561**	**581**	**601**	**623**	**644**	**667**	**690**	**714**	**739**	**765**	**792**	**820**	**848**	**878**
VOC savings non-incremental traffic (Million FCFA)	0	0	0	0	397	411	425	440	456	472	488	505	523	541	560	580	600	621	643	665	689	713	738	764
VOC savins incremental traffic (Million FCFA)	0	0	0	0	60	62	64	66	68	71	73	76	78	81	84	87	90	93	96	100	103	107	111	115
Time savings (Million FCFA)	**0**	**0**	**0**	**0**	**141**	**146**	**151**	**156**	**162**	**167**	**173**	**179**	**186**	**192**	**199**	**206**	**213**	**220**	**228**	**236**	**244**	**253**	**262**	**271**
Time savings non-incremental traffic	0	0	0	0	108	112	116	120	124	129	133	138	143	148	153	158	164	170	176	182	188	195	201	208
time savings incremental traffic	0	0	0	0	33	34	35	36	37	39	40	41	43	44	46	47	49	51	53	55	56	58	60	63
Accidents savings (Million FCFA)	**0**	**0**	**0**	**0**	**2778**	**3762**	**5041**	**5766**	**6179**	**6396**	**6620**	**6851**	**7091**	**7339**	**7596**	**7862**	**8137**	**8422**	**8717**	**9022**	**9338**	**9664**	**10003**	**10353**
Mortal accidents (Million FCFA)	0	0	0	0	814	636	750	859	513	531	550	569	589	609	631	653	676	699	724	749	775	803	831	860
Severe accidents (Million FCFA)	0	0	0	0	274	1195	1716	1930	2516	2604	2695	2790	2887	2988	3093	3201	3313	3429	3549	3674	3802	3935	4073	4216
Light accidents (Million FCFA)	0	0	0	0	1691	1931	2575	2977	3150	3260	3374	3493	3615	3741	3872	4008	4148	4293	4443	4599	4760	4927	5099	5277
CO2 emissions impact (Million FCFA)	**0**	**0**	**0**	**0**	**-14**	**-15**	**-15**	**-16**	**-16**	**-17**	**-18**	**-18**	**-19**	**-23**	**-24**	**-24**	**-25**	**-26**	**-30**	**-31**	**-32**	**-33**	**-34**	**-35**
Job creation during construction phase (Million FCFA)	**11268**	**11268**	**11268**	**11268**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**	**525**
Total annual flow	**-19957**	**-6256**	**-3500**	**0**	**3855**	**4862**	**6161**	**6906**	**7338**	**7575**	**7819**	**8071**	**8333**	**8599**	**8878**	**9166**	**9464**	**9772**	**10088**	**10417**	**10757**	**11108**	**11470**	**11845**
NPV	**-19957**	**-5779**	**-2985**	**0**	**2805**	**3268**	**3825**	**3960**	**3886**	**3705**	**3532**	**3368**	**3211**	**3061**	**2919**	**2783**	**2654**	**2531**	**2414**	**2302**	**2195**	**2094**	**1997**	**1905**
Accumulated NPV	**-19957**	**-25735**	**-28721**	**-28721**	**-25915**	**-22647**	**-18822**	**-14863**	**-10976**	**-7271**	**-3739**	**-371**	**2840**	**5901**	**8820**	**11604**	**14258**	**16789**	**19203**	**21505**	**23700**	**25794**	**27791**	**29696**

EIRR	**15%**

Description	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Discounted Benefits	0	0	0	0	2828	3287	3843	3978	3905	3724	3552	3387	3231	3081	2939	2804	2676	2553	2435	2324	2218	2117	2020	1928
Discounted Costs	19957	5779	2985	0	23	19	18	18	19	19	19	20	20	20	20	21	21	21	22	22	23	23	23	24

3.3 Saraya-Kita regional road project

Description	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Discount Rate	**8%**																							
	100%	93%	86%	80%	74%	68%	63%	59%	54%	50%	47%	43%	40%	37%	35%	32%	30%	27%	25%	24%	22%	20%	19%	17%
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Investment	**-73346**																							
Mali investment	**-64514**																							
Civil works	-46536																							
Civil works (Bridges)	-16000																							
Control and surveillance 2009	-1641																							
Others	-337																							
Senegal investment	**-8832**																							
Traffic forecasting (Million Vehicles)	**61692**	**63986**	**66367**	**457916**	**475095**	**492927**	**511437**	**530652**	**550597**	**571303**	**592797**	**615109**	**638273**	**662320**	**687284**	**713200**	**740107**	**768040**	**797041**	**827151**	**858411**	**890868**	**924566**	**959554**
Average yearly traffic forecasted without the project (Million v	61692	63986	66367	68837	71401	74062	76823	79689	82663	85750	88954	92279	95730	99312	103029	106888	110893	115051	119366	123845	128495	133321	138331	143532
Average Generated traffic (Million vehicles)	0	0	0	389078	403693	418865	434614	450962	467934	485552	503843	522831	542543	563008	584254	606312	629213	652990	677675	703306	729917	757547	786235	816022
Costs	**0**	**0**	**0**	**643**	**643**	**5193**	**643**	**643**	**643**	**16688**	**643**	**643**	**643**	**643**	**643**	**643**	**643**	**16688**	**643**	**643**	**643**	**643**	**643**	**643**
Operation and maintenance of the road (Million FCFA)				643	643	5193	643	643	643	16688	643	643	643	643	643	643	643	16688	643	643	643	643	643	643
Residual value of investment																								
Annual Operating Flow	**0**	**0**	**0**	**-643**	**-643**	**-5193**	**-643**	**-643**	**-643**	**-16688**	**-643**	**-643**	**-643**	**-643**	**-643**	**-643**	**-643**	**-16688**	**-643**	**-643**	**-643**	**-643**	**-643**	**-643**
Total Benefits	**0**	**0**	**0**	**18021**	**18974**	**18722**	**14871**	**21073**	**20899**	**21678**	**7368**	**24175**	**24195**	**26006**	**26015**	**26984**	**28916**	**29032**	**14054**	**32147**	**32383**	**33589**	**35766**	**37063**
VOC savings (Million FCFA)	**0**	**0**	**0**	**13738**	**14225**	**14728**	**15250**	**15791**	**16351**	**16932**	**17533**	**18157**	**18803**	**19472**	**20166**	**20885**	**21630**	**22402**	**23203**	**24032**	**24892**	**25782**	**26706**	**27663**
VOC savings non-incremental traffic (Million FCFA)	0	0	0	4148	4303	4464	4632	4805	4986	5173	5367	5569	5778	5996	6222	6456	6699	6952	7214	7486	7768	8062	8366	8682
VOC savins incremental traffic (Million FCFA)	0	0	0	9591	9922	10264	10618	10986	11365	11759	12166	12588	13024	13476	13945	14429	14931	15451	15989	16546	17123	17721	18340	18981
Time savings (Million FCFA)	**0**	**0**	**0**	**362**	**376**	**390**	**405**	**421**	**437**	**454**	**472**	**490**	**509**	**529**	**550**	**571**	**593**	**616**	**640**	**665**	**691**	**718**	**745**	**774**
Time savings non-incremental traffic	0	0	0	93	97	100	104	108	113	117	121	126	131	136	141	147	152	158	164	171	177	184	191	199
time savings incremental traffic	0	0	0	269	279	290	301	313	325	337	351	364	378	393	408	424	441	458	476	494	513	533	554	576
Accidents savings (Million FCFA)																								
Mortal accidents (Million FCFA)																								
Severe accidents (Million FCFA)																								
Light accidents (Million FCFA)																								
CO2 emissions impact (Million FCFA)	**0**	**0**	**0**	**-73**	**-75**	**-78**	**-81**	**-84**	**-87**	**-90**	**-93**	**-97**	**-100**	**-121**	**-126**	**-130**	**-135**	**-140**	**-159**	**-165**	**-171**	**-177**	**-183**	**-190**
Job creation during O&M phase (Million FCFA)	**0**	**0**	**0**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**21**
Savings on deviated merchandizes	**0**	**0**	**0**	**3930**	**4083**	**4242**	**4407**	**4579**	**4757**	**4943**	**5136**	**5336**	**5544**	**5760**	**5985**	**6219**	**6461**	**6714**	**6976**	**7249**	**7532**	**7826**	**8132**	**8450**
Savings on maintenance cost	**0**	**0**	**0**	**0**	**303**	**-624**	**-5174**	**303**	**-624**	**-624**	**-15743**	**-624**	**-624**	**303**	**-624**	**-624**	**303**	**-624**	**-16669**	**303**	**-624**	**-624**	**303**	**303**
Increase in earnings from other sectors				**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**42**
Total annual flow	**-73346**	**0**	**0**	**17378**	**18331**	**13529**	**14229**	**20430**	**20256**	**4990**	**6725**	**23533**	**23553**	**25364**	**25372**	**26341**	**28273**	**12344**	**13411**	**31504**	**31740**	**32946**	**35123**	**36421**
NPV	**-73346**	**0**	**0**	**13837**	**13529**	**9255**	**9021**	**12006**	**11033**	**2519**	**3147**	**10207**	**9468**	**9451**	**8762**	**8432**	**8388**	**3394**	**3418**	**7443**	**6950**	**6687**	**6607**	**6350**
Accumulated NPV	**-73346**	**-73346**	**-73346**	**-59508**	**-45979**	**-36724**	**-27703**	**-15697**	**-4663**	**-2144**	**1003**	**11209**	**20678**	**30128**	**38890**	**47322**	**55710**	**59105**	**62523**	**69966**	**76916**	**83602**	**90209**	**96559**
												892,00												
EIRR	**17%**																							

Description	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Discounted benefits	0	0	0	14349	14003	12807	9429	12384	11383	10945	3448	10485	9727	9690	8984	8637	8579	7983	3582	7594	7091	6817	6728	6462
Discounted costs	73346	0	0	512	474	3552	407	378	350	8425	301	279	258	239	222	206	191	4589	164	152	141	130	121	112

Economic Evaluation at Appraisal Amounts in million CFA Francs

Year	Investment	Savings on Road Traffic Associated Costs					Savings on Deviated Rail Traffic Bamako-Dakar					Savings on Deviated Road Traffic Bamako-Abidjan					Cashflow
		Savings on VOC	Savings on Maintenance Costs				Passengers- number	Merchandizes-tons			Total	Passengers- number	Merchandizes-tons			Total	
			Mali		Senegal			Solid	Petroleum	Coton			Solid	Petroleum	Coton		
			Routine	Periodic	Routine	Periodic	46 625	293 400	26 780	66 917		-	51 621	198 675	-		
2004							-	-	-	-	-	-	-	-	-	-	-
2005	(13 071.00)						-	-	-	-	-	-	-	-	-	-	*(13 071.00)*
2006	(20 913.60)						-	-	-	-	-	-	-	-	-	-	*(20 913.60)*
2007	(18 299.40)						-	-	-	-	-	-	-	-	-	-	*(18 299.40)*
2008		2 921.46	4.40	-	0.77	-	507.47	2 010.38	104.84	394.27	*3 016.96*	-	380.09	1 192.05	-	*1 572.14*	*7 515.73*
2009		3 030.50	4.40	-	0.77	-	522.69	2 090.79	109.04	406.10	*3 128.62*	-	395.29	1 239.73	-	*1 635.02*	*7 799.31*
2010		3 143.77	4.40	453.25	0.77	331.50	538.37	2 174.42	113.40	418.29	*3 244.48*	-	411.10	1 289.32	-	*1 700.42*	*8 878.59*
2011		3 261.28	4.40	-	0.77	-	554.52	2 261.40	117.93	430.83	*3 364.69*	-	427.54	1 340.89	-	*1 768.44*	*8 399.58*
2012		3 383.26	4.40	-	0.77	-	571.16	2 351.86	122.65	443.76	*3 489.43*	-	444.65	1 394.53	-	*1 839.18*	*8 717.03*
2013		3 509.82	4.40	453.25	0.77	331.50	588.29	2 445.93	127.56	457.07	*3 618.85*	-	462.43	1 450.31	-	*1 912.74*	*9 831.34*
2014		3 641.17	4.40	(8 417.50)	0.77	(2 569.13)	605.94	2 543.77	132.66	470.78	*3 753.16*	-	480.93	1 508.32	-	*1 989.25*	*(1 597.88)*
2015		3 777.55	4.40	-	0.77	-	624.12	2 645.52	137.97	484.91	*3 892.51*	-	500.17	1 568.66	-	*2 068.82*	*9 744.06*
2016		3 918.95	4.40	453.25	0.77	331.50	642.84	2 751.34	143.49	499.46	*4 037.12*	-	520.17	1 631.40	-	*2 151.58*	*10 897.57*
2017		4 065.92	4.40	-	0.77	-	662.13	2 861.39	149.23	514.44	*4 187.19*	-	540.98	1 696.66	-	*2 237.64*	*10 495.91*
2018		4 218.37	4.40	-	0.77	-	681.99	2 975.85	155.19	529.87	*4 342.91*	-	562.62	1 764.53	-	*2 327.14*	*10 893.59*
2019		4 376.73	4.40	453.25	0.77	331.50	702.45	3 094.88	161.40	545.77	*4 504.51*	-	585.12	1 835.11	-	*2 420.23*	*12 091.38*
2020		4 541.01	4.40	-	0.77	-	723.53	3 218.68	167.86	562.14	*4 672.20*	-	608.53	1 908.51	-	*2 517.04*	*11 735.42*
2021		4 711.42	4.40	-	0.77	-	745.23	3 347.43	174.57	579.01	*4 846.24*	-	632.87	1 984.85	-	*2 617.72*	*12 180.54*
2022		4 888.53	4.40	(7 964.25)	0.77	(2 237.63)	767.59	3 481.32	181.56	596.38	*5 026.84*	-	658.18	2 064.24	-	*2 722.43*	*2 441.10*
2023		5 072.33	4.40	-	0.77	-	790.62	3 620.58	188.82	614.27	*5 214.28*	-	684.51	2 146.81	-	*2 831.33*	*13 123.10*
2024		5 263.05	4.40	-	0.77	-	814.33	3 765.40	196.37	632.70	*5 408.80*	-	711.89	2 232.69	-	*2 944.58*	*13 621.60*
2025		5 461.03	4.40	453.25	0.77	331.50	838.76	3 916.01	204.23	651.68	*5 610.68*	-	740.37	2 321.99	-	*3 062.36*	*14 923.99*
2026		5 666.71	4.40	-	0.77	-	863.93	4 072.65	212.39	671.23	*5 820.20*	-	769.98	2 414.87	-	*3 184.86*	*14 676.94*
2027		5 880.09	4.40	-	0.77	-	889.85	4 235.56	220.89	691.36	*6 037.66*	-	800.78	2 511.47	-	*3 312.25*	*15 235.17*
2028		6 101.51	4.40	-	0.77	-	916.54	4 404.98	229.73	712.10	*6 263.35*	-	832.81	2 611.93	-	*3 444.74*	*15 814.77*

Economic Rate of Return = 13.9%

Net Present Value (NPV) at 10% discount rate = US $ (22.929) million

Note: - ***Savings for deviated rail traffic Bamako-Dakar:*** Savings on unit costs are: 10884 CFAF/passenger; 6852/ton solid merchandizes; 3915/ton petroleum; 5892/ton cotton.
- ***Savings for deviated road traffic Bamako-Abidjan:*** Savings on unit costs are: 7363/ton solid merchandizes; 6000/ton petroleum.

Source: (IsDB, 2003)

ANNEX 3

Instrument for data collection: List of information required for the economic evaluation of the projects

(Liste de données nécessaires pour l'évaluation de la rentabilité économique des projets d'Infrastructure)

Secteur	Données
1. **Routes**	1.1 Description détaillée de l'investissement : périmètre, tracé, population impactée, type de route, financement, durée d'implémentation, output attendu, etc.
	1.2 Le coût total de projet d'investissement (CAPEX) et les coûts des dépenses d´exploitation (OPEX) détaillés : prévisionnels et constatés sur la durée de vie du projet.
	1.3 Durée de vie de l'investissement et règles d'amortissement.
	1.4 Coût du financement de l'investissement et plan de remboursement.
	1.5 Consommation total de carburant (dans la zone d'étude) avant et après le projet.
	1.6 Consommation moyenne de carburant per véhicule avant et après le projet.
	1.7 Vitesse moyenne par véhicule avant et après le projet.
	1.8 Temps moyen de trajet avant et après le projet.
	1.9 Taux d'accident enregistré avant et après le projet.
	1.10 Distance qui sépare les habitations des bandes de circulation après le projet.

	1.11 Largeur de la chaussée.
	1.12 Taux moyen d’occupation des véhicules.
	1.13 Trafic enregistré (en nombre de véhicules) par mois et par an, avant et après le projet.
	1.14 Emission de CO2 avant et après le projet.
	1.15 Coût moyen d'entretien des véhicules avant et après le projet.
	1.16 Nombre d'accidents avant et après le projet, répartis en accidents mortels et non mortels.
	1.17 Niveau de revenu par habitant.
	1.18 Espérance de vie.
	1.19 Coût moyen d'une hospitalisation dans le pays.
	1.20 Coût moyenne de carburant dans la zone d´étude ou prix de carburant par an à partir de la fin de la construction de projet.
	1.21 Salaire moyenne par employé pendant la phase de la construction du projet.
	1.22 Nombre d´employé pendant la phase de la construction du projet.
	1.23 Nombre d’employé pendant la maintenance de la route.
	1.24 Nombre d’employé dans la zone du projet.
	1.25 Salaire moyen par habitant.
***Pour le projet régional**	1.26 Valeur des échanges transfrontaliers avant et après le projet.

1. Production d'électricité	1.1 Description détaillé de l'investissement : périmètre, financement, durée d'implémentation, output attendu, etc.
	1.2 Le coût total de projet d'investissement (CAPEX) et les coûts des dépenses d´exploitation (OPEX) détaillés : prévisionnels et constatés sur la durée de vie du projet.
	1.3 Coût du financement de l'investissement et plan de remboursement
	1.4 Durée de vie de l'investissement et règles d'amortissement
	1.5 La demande (consommation) nationale en électricité avant et après projet sur une année. (MWh et MW)
	1.6 La consommation quotidienne sur une année. (Au niveau nationale, MWh et MW)
	1.7 Estimation du besoin totale en électricité sur la ville, la région du projet mais aussi au niveau national. (MWh et MW)
	1.8 Coûts de production de l'électricité du nouveau projet et coût de production national moyen. (En Franc CFA/MWh)
	1.9 Coûts de l'électricité avec des générateurs individuels, pour les particuliers et les entreprises. (En Franc CFA/MWh)
	1.10 Prix de l'électricité pour l'utilisateur final avant et après projet. (En Franc CFA/KWh)
	1.11 La capacité totale disponible et la capacité supplémentaire apportée par l'infrastructure.
	1.12 Capacité totale disponible pour type de carburant en MW (biomasse, pétrole, énergie hydraulique, etc.)
	1.13 Importation et exportation d'électricité avant et après projet.

	1.14 Taux de rendement des centrales électriques avant et après projet. Efficacité des centrales électriques. Pour exemple, pour une centrale thermique le carburant utilisé per MWh.
	1.15 Emission de CO_2 dans la production d'électricité avant et après le projet.
	1.16 Coût de l´énergie non distribuée (CEND) avant et après le projet.
	1.17 L´énergie non distribuée avant et après le projet (VOLL en anglais)
	1.18 Coût moyen pondéré du capital pour la compagnie nationale d´électricité.
	1.19 Salaire moyen par employé pendant la phase de la construction du projet.
	1.20 Nombre d´employé pendant la phase de la construction du projet
	1.21 Nombre d'employé pendant la phase de maintenance du projet.