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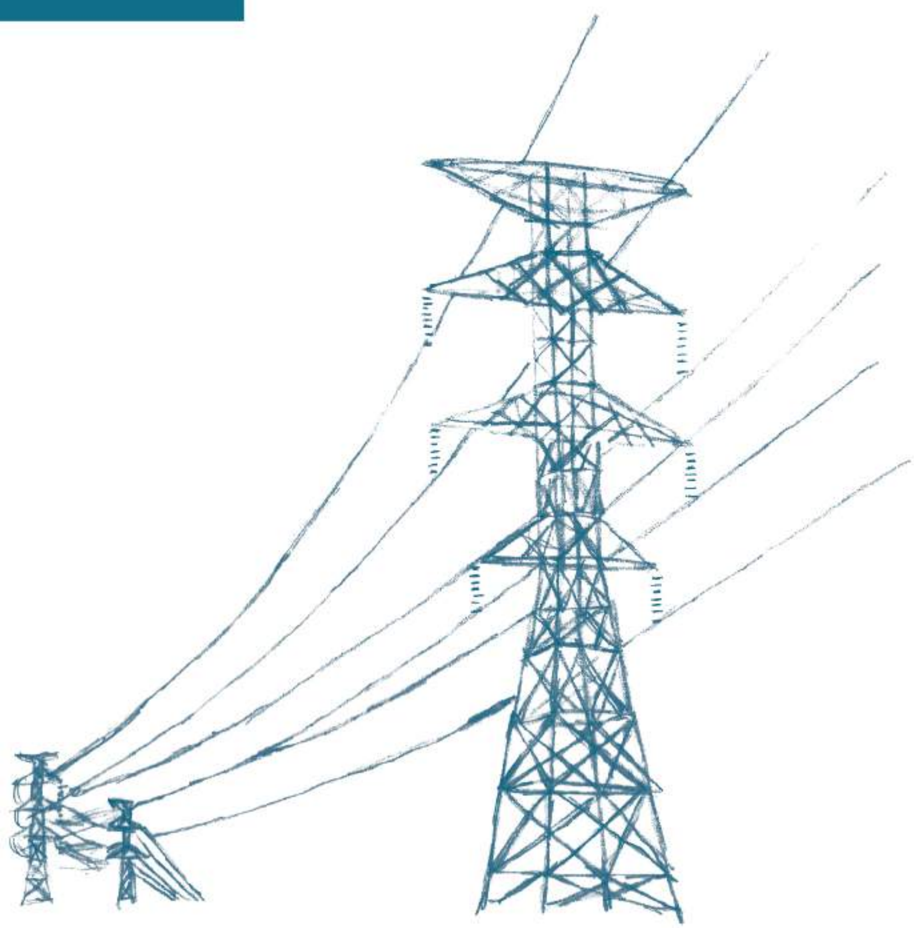
Benefit-Cost Analysis

Transmitting and Distributing Electricity in Haiti



COPENHAGEN CONSENSUS CENTER

Haïti Priorise
Un plan de **développement** alternatif

TRANSMITTING AND DISTRIBUTING ELECTRICITY IN HAITI

Haïti Priorise

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Abstract

This paper presents an evaluation of the costs and benefits of two interventions in the field of electrical power in Haiti and their benefit/cost ratio (BCR). This involves the construction of a national electricity transmission network and the rehabilitation and extension of electricity distribution networks across the main localities of the country. Specifically, the report analyzes the existing situation and evaluates the investment and operating costs of these planned interventions as well as their economic and social impacts.

Haiti is a poor country with a very low rate of electricity coverage. Inadequate electricity production is an obstacle to the development of its economic potential. The electrical system consists of a set of isolated networks supplying certain localities. In order to increase the supply of electricity, it is necessary to invest in electricity supply infrastructure alongside production. The costs of the proposed interventions are, however, high in relation to the financial constraints of the country. It is therefore necessary to prioritize potential investments based on their expected impacts.

The results of the study show the direct investment of 1.628 billion U.S. dollars over a period of 15 years in electricity transmission networks and direct investment of approximately 228 million U.S. dollars over a period of 10 years in distribution networks. These have been economically profitable for present value scenarios at the rates of 3%, 5% and 12% over the lifetimes of the interventions.

For example, at the 5% discount rate the transmission network intervention has a BCR of 6.18 and the distribution network intervention has a BCR of 10.02

The report concludes that, although both interventions have significant benefits, many conditions, however, remain to be met for the implementation of these interventions, including institutional changes and effective measures to reduce commercial losses.

Policy Summary

Overview and context

Haiti is the least electrified country and the country using the highest rate of biomass as a source of energy in the Americas. The lack of electricity is an obstacle to economic and social development. At the same time, the development of the energy sector in a sustainable way is influenced by economic development. The electric coverage rate in Haiti is less than 25%. The cost of production is high and the commercial losses are enormous.

This document evaluates the benefit/cost ratio (BCR) of two interventions aimed at increasing access to electricity and improving the reliability and efficiency of the electric system in Haiti. The interventions are aimed at developing electrical systems to provide electricity 24 hours a day to about 50% of the population by 2030.

The first intervention, National Transmission Network, proposes the building of an electrical system linking the production centers to the consumption centers of the country in five years. Its components are the construction of about 1,079 km of high voltage lines, construction of 12 substations and a national energy control center.

The second, Distribution Networks, consists of the rehabilitation of 1,920 km of distribution lines, the construction of 1,350 km of distribution lines and the connection of approximately 750,000 new subscribers over 10 years across about 37 municipalities of the country.

Factors related to implementation

The interventions require additional studies of engineering and financial feasibility, financial arrangements, and institutional and organizational set-up. The preliminary direct costs of the transmission system intervention are estimated at 1.628 billion dollars and those of the distribution network intervention are 228 million dollars. These amounts are significant for a country like Haiti. It is conceivable that the call for private domestic and foreign capital may be necessary.

Potential revenue sources

Revenue will come from the sale of electricity delivery services to households and businesses, and if the conditions are met, the financial profitability of the interventions is possible.

The main indicators of intervention success are:

- Studies of planning, engineering, and financial feasibility carried out
- Organizational and financial arrangement
- Implementation plan for the adopted intervention program
- Launch of the intervention program implementation
- Increases in the rate of access to electricity
- Increase in electricity consumption per capita
- Increase in GDP per capita
- Evidence of improvement of the living conditions of the population
- Evidence of poverty reduction

Potential intervention implementation partners are:

- The Haitian government
- The Haitian and foreign private sector
- International financial institutions

The main stages in the implementation of the interventions include:

- Obtaining funding
- Initiation of the project by the Haitien government
- Engagement of a consulting engineering firm for detailed studies
- Call for tenders
- Establishment of a project management unit

There was an attempt to create a national electricity transmission network in the early 1990s, almost at the same time as our neighbors Jamaica and the Dominican Republic made their attempt. The Haitian project failed while our neighbors were able to develop their national networks. The reasons for this failure are multiple: first, there is the political and economic crisis that Haiti has experienced from the late 1980s until today. Next is the lack of support from financial backers who conditioned their assistance on the privatization of the EDH; finally, more recently, there has been a lack of interest on the part of the international community to finance major infrastructure projects in favor of small off-grid or micro-grid electrification projects.

Risks

There are several obstacles to the development of the national network:

1. Level of electricity theft
2. Political instability, lack of cohesion and vision at the political level in the country
3. Failure and dependence of the state on the international community
4. Lack of administrative and legal systems to combat fraud and corruption and to ensure protection property rights and compliance with standards in general
5. Weakness of government institutions and lack of development strategy
6. Anarchic urbanization
7. Lack of local capital for infrastructure development

Benefits

The two interventions will have significant positive effects compared to their costs, to the benefit of the general Haitian population, consumers and business people

1. Reduced cost of the provision of electricity
2. Contribution to increased domestic production
3. Facilitation of the integration of clean energy sources
4. Improved quality of service
5. Improved social services, such as education and health

Unmeasured benefits

There are many unmeasured benefits, in particular:

1. Reduction in energy theft
2. Reduction of crime levels and improved sense of security
3. Improvement of the condition of women and children in Haiti
4. Job creation
5. Improvement of the trade balance
6. Economic decentralization

The report shows in Table 1 below that at the 5% discount rate, for example, the transmission network intervention has a BCR of 6.18 and the distribution networks intervention has a BCR of 10.02.

Table 1. Summary Table
Total Net Present Values in million USD, 2016

Interventions	Discount Rate	Benefit	Cost	Benefit-Cost Ratio
National Transmission Network	5%	12,906	2,087	6.18
Distribution Networks	5%	6,577	657	10.02

Both interventions are economically viable. However, in order to ensure their financial viability, certain conditions must be met, in particular institutional changes and effective measures to reduce commercial losse

1. Introduction

The purpose of this paper is to determine the Benefit/Cost (BCR) ratios of two interventions in the electric power sector in Haiti. The first intervention is the construction of a national electricity transmission network and the second is the rehabilitation and extension of distribution networks throughout the country. The study included an analysis of the context and existing situation, a projection of demand, technical specifications of the works and evaluation of the costs of the interventions, as well as their benefits over the lifetime of the interventions. The analysis additionally includes the calculation of the present values of 3%, 5% and 12% and the calculation of the BCRs for these different discount rates.

2. Context

The economic situation in Haiti is catastrophic. Growth struggles to manifest and poverty is massive. The political situation has been unstable for decades and national institutions are failing. It is not surprising that the energy problem, particularly the electricity problem, is so acute. There is no way to ensure Haiti's economic growth without satisfying the electricity demands necessary for modern society. However, Haiti has much economic potential only waiting for conditions to be met to manifest. It has opportunities in mining, tourism, agriculture, services, small industry and agribusiness, which are hampered by the inadequacy of the electricity system.

The study adopts a perspective of the economy as a dynamic, adaptive and environmentally sensitive system[1]. It assumes that the interventions are likely to have substantial effects on the economy by providing the benefits of electrical energy in quantity, quality and competitive cost to all regions of the country.

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[1] Beinhocker, E. D., (2007)

Electrical systems, a part of economic systems, have some surprising economic effects. Economic systems and energy systems are complex phenomena that are mutually dependent. Energy systems and economic systems reinforce each other in a nonlinear way in a feedback loop.

Transforming the Haitian economy requires not only adequate economic infrastructure but also suitable institutions, including the rules of the game, values, and visions. From the perspective of dynamic systems, the economy adapts to technologies and institutions. Thus, electricity networks, like road and telecommunications networks, can have multiplier effects. The transmission network will allow distribution companies to source their energy, capacity, and ancillary services on the basis of long-term or short-term competitive markets. It will allow aggregated demand to be met by more efficient plants because of economies of scale, greater diversity of energy sources and greater competition. The real problem with the supply of electricity is the lack of conditions for a reliable supply at a reasonable cost. Consumers who can afford to buy their own electricity production equipment.

The study does not directly address the specific problems of electricity supply but assumes a close link between the networks, on the one hand, and the market structures of electricity, technology and production costs on the other. In addition, it assumes a strong and direct correlation between per capita electricity consumption and economic growth.

Network interventions are not alternatives to electricity production. They are complementary to the infrastructures of power generation. The proposed transmission network is compatible with all production technologies and primary sources of energy: thermal or renewable.

The biggest obstacle to the development of the electricity sector in Haiti is the weakness of institutions, manifested particularly by the deficiency of respect for property rights, the basic rules of justice, by chronic crises of governability and the general level of corruption. Poverty constitutes another dampering factor. A large proportion of the population cannot afford electricity but considers this commodity as a fundamental need which it cannot do without. This leads to the flagrant and massive theft of electricity, which is no longer considered socially reprehensible. Theft of electricity severely affects the income of the EDH, which is no longer able to carry out its mission. Consequently, it is unable to find the funds necessary to extend and improve infrastructure.

The dysfunction of Haiti's electricity system is worsening from day to day, despite the good intentions that, unfortunately, are not accompanied by the will and ability to straighten out state institutions.

3. Existing Situation

3.1. State of networks

Haiti's electricity system consists of several independent regional networks. These networks, with the exception of the metropolitan area of Port-au-Prince, are powered by small generators. The largest plants, located in the departmental capitals, operate generators of 500 kW to 1MW. About 35 small municipalities are powered by units from 60 kW to 500 kW.

3.2. Production costs

Production costs are high not only because of the technologies used but also because of the market structure. According to a report by the Ministry of the Economy and Finance, EDH purchases energy from three private producers (SOGENER, HAYTRAC, EPOWER) and the Petion, Bolivar and Marti mixed power plants at an average price of $ 0.2705 per kWh. In addition, in 2006, EDH estimated that independent producers' costs reached 7.74 gourdes per kWh or 9.50 gourdes, including fuel. According to MTPTC, BME and EDH (2006), the average cost of electricity from new power plants could range from $0.0879 to $0.0847 per kWh. Also, according to Schnitzer, D. et al. (2014), the rate of $0.35 per kWh charged by EDH could be reduced by $0.10/kWh if other technology were adopted.

3.3. Technologies

The cost of production varies according to the technology. Due to the fragmentation of the Haitian electrical networks, it is not possible to install generators of very high capacity without causing stability problems. Certain technologies, such as steam plants and combined-cycle turbine plants, are profitable only from a minimum threshold of 50 MW. The use of small generators results in high financial costs and increases air and soil pollution.

EDH plants in the Port-au-Prince metropolitan area include, in addition to the 54 MW Péligre hydroelectric plant, plants that can operate on heavy fuel oil, ranging in size from 7 to 10 MW. The metropolitan area is also supplied by independent producers operating small generators ranging from 1 to 2 MW, according to MTPTC, BME, and EDH (November 2006).

3.4. Electricity market structures

The structure of the electricity markets in Haiti is markedly different from those of the Dominican Republic and Jamaica, principally due to the existence of a national transmission network in these countries.

The Haitian market comprises five isolated areas, including the metropolitan area, Port-au-Prince, which is by far the largest with 60% of total demand, and five other remote regions and a multitude of micro-networks. Electricity production in large cities is largely provided by independent producers, who enjoy monopoly or oligopoly situations. The country's peak demand for 2008 was estimated at 215 MW, but net production was only about 600 GWh. Haiti has 72 generators totaling 155 MW, on average 2.15 MW per generator.

Jamaica has a single vertically-integrated electricity distributor that is responsible for the production, transmission and distribution of electricity. It also buys electricity from four independent producers. The country's peak demand in 2008 was 622 MW, with net production of more than 4,100 GWh. Jamaica has 32 generators totaling 769 MW, on average 24 MW per generator.

The Dominican Republic has eleven private thermal power plants, a state-owned hydroelectric power plant, five large and five small production companies. There are three private distribution companies and one public distribution company and one public transmission company. The country's peak demand for 2008 was 2,168 MW, with net production of more than 11,600 GWh. The Dominican Republic has 42 generators totaling 2,883 MW, on average 68.64 MW per generator.

3.5. Access rate and consumption level

The rate of access to electricity, which is the ratio of the number of households connected (legally or illegally) to the total number of families, has not changed significantly from 25% over the years, according to all sources. On the other hand, per capita consumption has varied over time. Annual electricity consumption per capita was 84 kWh in 2000, 30 kWh in 2004 and 21 kWh in 2011[2]. These variations suggest the combined effects of population growth and the deficit in energy production. Demand is increasing as a result of soaring demography and rapid urbanization. Cities develop in an anarchic way and increase the burden on the EDH. Households and businesses are obliged to use alternative means to compensate for the failures of the electrical system. They use generators, batteries and other high-cost systems.

3.6. Quality of service

The quality of service provided by the EDH is deplorable because of daily rationing and untimely power cuts. Failures are common due to breaks in the conductors and explosion of distribution transformers due to overloads caused by network piracy. The EDH can provide barely 12 hours of electricity per day in some neighborhoods. Broadly speaking, access to electricity is precarious and quality does not meet the needs of the country's economic and social development. The status quo is unsustainable in light of its impact on the economic, social and political situation. Two interventions in the field of transmission and distribution present opportunities to improve the technical and economic performance of electrical systems.

4. Assumptions

The study was carried out on the basis of certain assumptions. The main ones, described below, are: rate of growth of demand, parameters and economics.

4.1. Scenarios

Each intervention is evaluated against a reference scenario, that is the scenario without intervention. The counterfactual scenario assumes that the existing model, namely the development of isolated regional networks, is retained. This offers the advantage of being less

[2] Worldwatch Institute (2014)

costly in terms of investment, however it offers fewer benefits. All scenarios share, however, the same projection of demand.

4.2. Growth rate of demand

Demand is projected over the period from 2017 to 2047 assuming an annual growth rate in demand of 5%, from 328 MW in 2017 to 1,390 MW in 2047, and an annual energy growth rate of 6%, from 1,263 GWh in 2017 to 6,695 GWh in 2047. This prediction is conservative because it does not take into account latent demand, which is difficult to estimate given the instability of Haitian reality.

The rate of 5% is that adopted by the majority of the studies conducted by Electricité d'Haïti (EDH), the World Bank and other consultants, such as the consulting firm Nextant [3]. The growth rate of energy demand is greater than that of power demand because of the anticipated effect of interventions on the load curve. The load factor, which is the ratio of the average power over the peak power, is assumed increased. The growth rate is difficult to determine with precision because it depends on many unpredictable factors, such as economic growth, the political environment and above all the loop effect of demand-side interventions that can be accelerated by the activation of latent demand. The 5% rate, therefore, corresponds to a conservative estimate that does not take into account the multiplier effect of interventions.

4.3. Economic parameters

The rate of total losses is estimated at 55% according to the data provided by EDH. We have assumed that 10% of the losses are technical and 45% are non-technical, commercial losses attributable to energy theft and under-invoicing. The study assumes that each intervention will help reduce technical losses by 25%. In addition, from the reference scenario to the intervention scenario, the load factor rises from about 44% to about 55%, with the rate of access to electricity rising from 25% to 50%. Investments in the transmission network are spread over a period of 15 years and evaluated over a period of 30 years, while investments in distribution networks are spread out over a period of 10 years and evaluated over 20 years. The actualization of the interventions' costs and benefits is made for discount rates of 3%, 5% and 12%. The program

[3] Nextant carried out a study of the interconnection of the Inter-Caribbean network on behalf of the World Bank.

consists of the construction of electric power delivery systems capable of supplying electricity reliably to about 50% of the population of most municipalities in Haiti by 2030.

The economic impact of the interventions was evaluated under the assumption of a strong correlation between electricity consumption and GDP. The anticipated benefits are also conditioned on an effective development strategy and a favorable environment. The economic situation is considered in its dynamism.

The study envisages a scenario similar to that experienced by the country when the Péligre hydroelectric plant was commissioned in the early 1970s. The availability of reliable and economical electricity had helped to spur growth that until then had been impossible. Port-au-Prince attracted investment in the domains of subcontracting, tourism and alternative industries. The growth was so significant that in no time the two other Péligre plant turbines had to be added and later the Varreux thermal power plant had to be built in order to meet not only the growth of demand, but also to compensate for the reduction of the Péligre production in the dry season.

The study assumes an impact of $4.70 of GDP per capita for each additional kWh consumed per capita. This figure has been determined from the 2010 data from the Worldwatch Institute study (2014).

5. Interventions

The two interventions that are the subject of this study are: (i) National Electricity Transmission Network and (ii) Distribution Networks. They are independent of each other and were assessed separately. Each of them aims to contribute to increasing access to electricity and improving reliability and efficiency of Haiti's electricity system by strengthening transmission and distribution networks.

5.1. National Transmission Network Intervention

The National Transmission Network intervention aims to connect regions of the country in an integrated system. The network will connect the following regional centers: Port-au-Prince, Jacmel, Jérémie, Gonaïves, Cap Haïtien, Môle Saint Nicolas, Fort Liberté and the Péligre plant. The development of a national electricity transmission network consists of three main components: (i) the construction of approximately 1,079 km of high-voltage power lines connecting the country's main cities; (ii) the extension of 12 substations across the country and (iii) the construction of a national energy control center.

Table 5.1 Capacities of Transmission Lines

High-Voltage Lines	Capacity	MVA Charge	Length of Lines
Carrefour Jacmel	2x 40 MVA	13	76
Varreux Gonaïves	2x40 MVA	78	142
Carrefour Petit-Gôave	2x 40 MVA	62	58
Petit Gôave Cayes	2x 40 MVA	56	125
Cayes Jérémie	2x 40 MVA	26	95
Varreux Gonaïves	2x 40 MVA	78	145
Gonaïves Cap Haïtien	2x 40 MVA	39	99
Port de Paix Môle Saint Nicolas	2x 40 MVA	6	72
Cap Haïtien Fort Liberté	2x 40 MVA	13	52
Péligre Cap-Haitien	2x 40 MVA	81	110
Cap Haïtien Port-de-Paix	2x 40 MVA	13	105

Detailed technical features of the facilities remain to be determined by engineering studies. The nominal voltage of the equipment considered belongs to the class of 115-135 kV nominal voltage. Pylons could be metal lattice in wooden poles. The capacities of lines and of the substations are determined from the projection of the power demand over the life cycle of the intervention and certain parameters such as the power factor and the load factor. The regional load distribution was made by extrapolation of the current loads. The elementary characteristics of the high-voltage lines are shown in table 5.1 above.

The main components of substations include not only power transformers but also other major equipment such as circuit breakers, disconnectors, protective equipment, remote control and communications equipment as well as civil engineering works. The characteristics of the substations are shown in Table 5.2 below.

Table 5.2 Capacities of Substations

Substations	2020			2032		
	QTE	MVA Capacity	MVA Charge	QTE	MVA Capacity	MVA Charge
Carrefour	3	20	62	3	20	111
Petit Gôave	2	5	6	1	5	12
Jacmel	2	10	13	1	10	23
Cayes	2	20	30	1	20	53
Jérémie	2	10	13	1	10	23
Gonaïves	2	20	39	2	20	70
Varreux	3	50	116	1	50	209
Môle Saint Nicolas	2	5	6	1	5	12
Fort Liberté	2	10	13	1	10	23
Péligre	2	50	78	1	50	139
Cap Haïtien	2	50	78	1	50	139
Port de Paix	2	5	6	1	5	12

Some of these substations exist but will be reinforced.

Costs National Electricity Transmission Network Intervention

The intervention costs in the national electricity transmission network include investment costs and operating costs. In this intervention, the environmental costs are not estimated. These are considered negligible. Costs are spread over the life of the intervention.

Investment Costs

Investment costs are calculated based on demand, assumptions and technical and economic parameters. Investment, spread over two periods of five years, is estimated to total nearly 1.628 billion dollars. Table 5.3 summarizes these investment costs in transmission networks.

Table 5.3: National Transmission Network Investment Costs
Undiscounted cumulative cost in million USD, 2016

Components	**2017 - 2021**	**2028 - 2032**	**US Millions**
Substations	348	189	537
High-Voltage Lines	1,079		1,079
Energy Control Center	8	4	12
Total	1,435	193	1,628

Transmission Network Operating and Maintenance Costs

Transmission network operating and maintenance costs include line maintenance costs, which are estimated at approximately $0.01/kWh, and the cost of technical losses on lines. It is assumed that maintenance costs do not vary from one scenario to the next, however, the rate of technical losses is reduced by 50% with the national network.

Benefits of National Transmission Network Intervention

The National Transmission Network has several operational, economic and social benefits. The national transmission network will help create the conditions for the functioning of a competitive wholesale electricity market and facilitate the introduction of other economic models for electricity service by mitigating monopolistic and oligopolistic trends.

The control center will help to improve the management of transactions with independent producers and ensure the economic dispatching of power plants by order of merit.

In addition, the national network will allow for the realization of economies of scale by making the installation of larger and more efficient production units possible. Also, it would allow the adoption of more economical production technologies. The national network will reduce the capacity reserves necessary to ensure the reliability of the system and thereby reduce capacity costs.

It will enable the integration of cleaner renewable energy sources, such as solar and wind turbines, whose intermittence can be economically mitigated by connection to the networks.

The transmission network will allow for reduction of the cost of rural electrification thanks to the installation of a high voltage network across the country integrating the currently isolated systems. It will avoid the multiplication of diesel microplants in the electrification of small localities. It offers the possibility of supplying the regions with sufficient energy from more efficient and reliable power plants.

The national network will contribute to reducing the cost of electrical system failure and its negative effects on the national economy. Above all, it will help increase productivity and boost economic growth, as anticipated by economists. It will help to support the development of business and the production of goods and services.

The social impact of the intervention has two components: the socio-economic benefits to the population in terms of improved living, education and health conditions, and the reduction of harmful CO_2 emissions.

Also, the connection of the country's largest hydroelectric power plant with an annual production capacity of 300 GWh to the national network will help reduce poverty. It could be used to subsidize the electricity supply to about 1 million households at a rate of 300 kWh per household per year.

Reduction of Production Costs

The study found that by making the functioning of a truly more competitive market and the adoption of more economical technologies possible, energy production costs could be reduced by about $0.10/kWh in the metropolitan area and $0.15/kWh in the provinces. Over the life of the project, the projected demand is 106,580 GWh and the production cost savings attributable to the transmission system are estimated at $8,643 billion, or $0.08/kWh on average.

Reduction of Undelivered Energy Costs

Undelivered energy costs include not only alternative production costs but also opportunity costs. According to several studies conducted in developing countries such as Haiti, the cost of undelivered energy ranges from $1.7 to $1.9 per kWh. According to EDH data, the cost of undelivered energy varies from $0.6 to $1.2/kWh; the present study assumes $1/kWh for undelivered energy. A 50% rate of undelivered energy and a 25% reduction in undelivered energy, of which 50% is attributable to the transmission network, creates a savings of $6.6 billion from the transmission network over the lifetime of the project.

Economic Impact

Table 5.4 below summarizes the values of expected benefits in terms of reduction of technical losses, delivery costs of undelivered energy in regions and Port-au-Prince, and reduction of CO_2 emission costs. The estimated value of the social and economic impacts of the intervention is $31.614 billion over the estimated life of the intervention.

Table 5.4: Estimation of the Benefits of the National Transmission Network (USD millions)

Benefits	Undiscounted	NPV 3%	NPV 5%	NPV 12%
Reduction of technical losses	952	543	388	148
Reduction of undelivered energy costs	6,415	3,659	2,614	1,000
Reduction in production costs Port-au-Prince	668	381	272	104
Reduction in production costs provinces	7,975	4,549	3,250	1,244
Reduction of CO2 emissions	1,347	768	549	210
Social impact	981	573	413	156
Economic impact	13,180	7,543	5,399	2,074
Residual value	97	40	22	3
Total	31,614	18,057	12,906	4,940

5.2 Distribution Networks Intervention

The distribution network intervention consists of the rehabilitation of 1,920 km of medium voltage and low voltage lines, the construction of 1,350 km of medium and low voltage lines, the connection of about 750,000 new subscribers through electronic meters that can be read remotely and updating the billing system.

Costs of Distribution Networks Intervention

The investment costs of the distribution networks intervention are summarized in Table 5.5 below.

Table 5.5: Costs of Investment in the Distribution Networks

Costs	Millions USD
Construction of distribution lines	34
Rehabilitation of distribution lines	19
Acquisition and installation of meters	75
Billing system update	100
Total	**228**

Benefits of Distribution Networks Intervention

The benefits of the distribution network intervention are similar to those of the National Transmission Network intervention described previously. The Distribution Networks intervention serves, on the one hand, to increase access to electricity and, on the other hand, to improve the quality of the service provided. The distribution network intervention will help increase the rate of access to electricity from 25% to more than 50% of the population. It will also allow for the reduction of technical losses and the costs of electricity production. It will help to reduce the costs of breakdowns and improve the living conditions of the population. The impacts of the distribution networks intervention can be summarized by (i) increase of operational efficiency through reduction of the rate of technical losses, breakdowns and meter reading costs; (ii) reduction of pollution; (iii) improvement of socio-economic conditions which will be measured by the effect on education, population health and well-being in general; and (iv) economic growth.

Increasing per capita electricity consumption will help to increase economic output and will lead to sustainable economic growth through investment attractiveness. Distribution networks will contribute to a reduction in production costs estimated at $0.02/kWh. The benefits of the Distribution Networks intervention are summarized in Table 5.6 below.

Table 5.6: Distributions Networks Estimation of Benefits (Millions USD)

Benefits	Undiscounted	NPV 3%	NPV 5%	NPV 12%
Reduction of technical losses	449	308	244	120
Reduction of undelivered energy costs	3,022	2,076	1,646	810
Reduction of production costs P-au-P	135	93	73	36
Reduction of production costs provinces	1,610	1,106	877	432
Reduction of meter-reading costs	22	14	11	5
Social impact	549	369	287	131
Economic impact	6,320	4,339	3,438	1,688
Total	12,107	8,306	6,577	3,223

6. Analysis of Benefits and Costs of Intervention

The direct costs of the transmission system intervention are estimated at $1.628 billion and those of the distribution networks intervention are $228 million. Table 6.1 below summarizes the discounted costs and benefits of the interventions and their Benefit/Cost ratios (BCR) for discount rates of 3%, 5%, and 12%.

Table 6. 1: Summary of Benefit/Cost Ratios
Total Net Present Values in million USD, 2016

Interventions	Discount Rate	Discounted Benefits	Discounted Costs	Benefit-cost Ratio	Quality of Data
National Transmission Network	3%	18,057	2,407	7.50	Strong
	5%	12,906	2,087	6.18	
	12%	4,940	1,500	3.29	
Distribution Networks	3%	8,306	769	10.80	Strong
	5%	6,577	657	10.02	
	12%	3,223	427	7.54	

6.1 Results

The results show that the interventions have BCRs ranging from 3.29 to 7.5 for the transmission network and 7.54 to 10.80 for the distribution network. The interventions are economically advantageous for the three discount rate scenarios of 3%, 5% and 12%.

6.2 Risks and Limitations

This report presents certain limitations without diminishing the force of its conclusions in relation to the objective pursued. First, investment costs are gross estimates based on similar projects and not the results of specific evaluations for the intervention sites. Only detailed engineering studies could give precise costs. Also, no analysis of the financial viability of the interventions was carried out. The costs of non-technical losses and strategies to reduce them were not taken into account. Some benefits have not been assessed either, for example, the positive effects on employment, the condition of women and children and economic decentralization. Finally, the expected benefits are conditional on achieving political stability and institutional reinforcement.

7. Conclusion

The two interventions, Transmission Network and Distribution Networks, are two important programs for the development of the electricity sector in Haiti. They are not only essential to the country's economic growth, but also are potentially profitable. The two interventions are independent of each other but complement each other. Their concurrence amplifies the benefits of each. The national transmission network allows, on the one hand, the creation of conditions for a more efficient market for electrical energy and, on the other hand, the delivery of energy at a more economic cost to different regions of the country. It will reduce production costs but also improve quality of service, and boost economic growth. The second distribution networks intervention will allow the distribution of electricity to households and businesses in a reliable and economical way. It also helps to reduce production costs and promote economic growth by improving productivity.

The analysis shows that both interventions are economically profitable at discount rates of 3%, 5% and 12%. For example, transmission network and distribution networks interventions have, respectively, BCRs of 6.18 and 10.2 at a discount rate of 5%. However, the financial feasibility of these interventions is conditional on certain institutional factors. The amount of direct investment required is so significant for a country like Haiti, that it is necessary for conditions to be met to attract investors in the sector.

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Haiti faces some of the most acute social and economic development challenges in the world. Despite an influx of aid in the aftermath of the 2010 earthquake, growth and progress continue to be minimal, at best. With so many actors and the wide breadth of challenges from food security and clean water access to health, education, environmental degradation, and infrastructure, what should the top priorities be for policy makers, international donors, NGOs and businesses? With limited resources and time, it is crucial that focus is informed by what will do the most good for each gourde spent. The Haïti Priorise project will work with stakeholders across the country to find, analyze, rank and disseminate the best solutions for the country. We engage Haitans from all parts of society, through readers of newspapers, along with NGOs, decision makers, sector experts and businesses to propose the best solutions. We have commissioned some of the best economists from Haiti and the world to calculate the social, environmental and economic costs and benefits of these proposals. This research will help set priorities for the country through a nationwide conversation about what the smart - and not-so-smart - solutions are for Haiti's future.

Haïti Priorise

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