Definitional Mission to Evaluate ICT Projects in Brazil: Volume 2: Equatorial Telecom

(Volumes 1, 3, 4, & 5 Issued Separately)

Draft Final Report

Submitted by

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The U.S. Trade and Development Agency

The U.S. Trade and Development Agency helps companies create U.S. jobs through the export of U.S. goods and services for priority development projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project planning activities, pilot projects, and reverse trade missions while creating sustainable infrastructure and economic growth in partner countries.

TABLE OF CONTENTS

Equatorial Telecom Broadband Backbone and Business Model

Definitional Mission Report

I. EXECUTIVE SUMMARY

Grantee: Equatorial Telecom

Activity Budget: $872,150
U.S. Export Potential: Fiber optic cables; optical electronics; systems and application software, servers, switches, storage, systems and application software, storage, virtualization software, and other data center equipment; total approximately US$56.7 million.

Equatorial Telecom (ET) seeks technical assistance for an international consultancy financed by USTDA to develop detailed plans to

1. Expand a growing fiber optic network based on optical ground wires (OPGW) hung from its transmission towers and use additional fiber optic and/or wireless connections to penetrate the commercial corporate and wholesale markets for Internet and telecommunications services in the states of Pará, Maranhão, Alagoas, and Piauí.
2. Identify potential partners to share in the investment and operating costs of the network through the exchange or rental of dark fiber and/or infrastructure (poles, ducts, cabinets, etc.).
3. Develop a business plan for building and operating the network at minimum cost to the company.
4. Design and construct a network data center and backup facility.

ET is a private sector company owned by Equatorial Energia, a Brazilian holding company that also owns electric power distribution companies in the states of Pará, Maranhão, Alagoas and Piauí. ET has an operating license from Anatel, the telecommunications regulator, to operate anywhere in Brazil and aspires to offer services throughout the country.

Summaries of all meetings held and contact details for participants are included as Annexes III and IV to this Final Report. The scope of work of the DM requires the development of detailed terms of reference (TOR) for activities recommended by the consultants, detailed consultant qualifications and a detailed project budget, with final approval of the activities by USTDA. This Final Report contains a summary of the DM process and findings. The DM U.S. firm's recommendations, the TOR, consulting team qualifications, and budget for the project are presented here.

II. PROJECT DESCRIPTION

A. Introduction

Brazil

Brazil is a recognized leader in ICT and in eGovernment in Latin America and among major emerging market economies worldwide. In keeping with Brazil's strong federal system, not only the national government but all state governments and a growing number of municipal governments have expanding eGovernment and ICT programs, of increasing sophistication. Ever more powerful, flexible and economical, ICT presents formidable new opportunities to accelerate social and economic development. But realizing this potential requires an enabling environment: appropriate incentives, policies and programs structured by governments that can also catalyze private investment. Brazil's national, state, and municipal governments recognize that a strong effort to bridge the digital divide is necessary in a country known for its high degree of income inequality.

In 2018 Brazil had 123 million Internet users, fourth largest in the world after China, India, and the United States. According to the annual survey conducted by the Brazilian Internet Steering Committee (CGI.br), in 2017 61% of Brazilian private homes had an Internet connection, up from 15% in 2006. Over the same period the percentage of individuals above 10 years of age who accessed the Internet in the three months prior to the annual survey conducted by CGI.br rose from 28 to 67. So, despite the undeniable progress, there is still a long way to go to achieve true digital inclusion. As of January 2019, the number of fixed broadband subscribers had reached only 31.2 million, or 12.4 per 100 inhabitants. Of these connections, 84% were over 2 Mbps and only 28% greater than 34 Mbps. But mobile broadband subscriptions had exploded to 182 million, of which 71% were 4G (LTE). While 3G and 4G mobile connections are useful, smart phones are less than ideal for many applications, especially e-learning, e-health, and eGovernment.

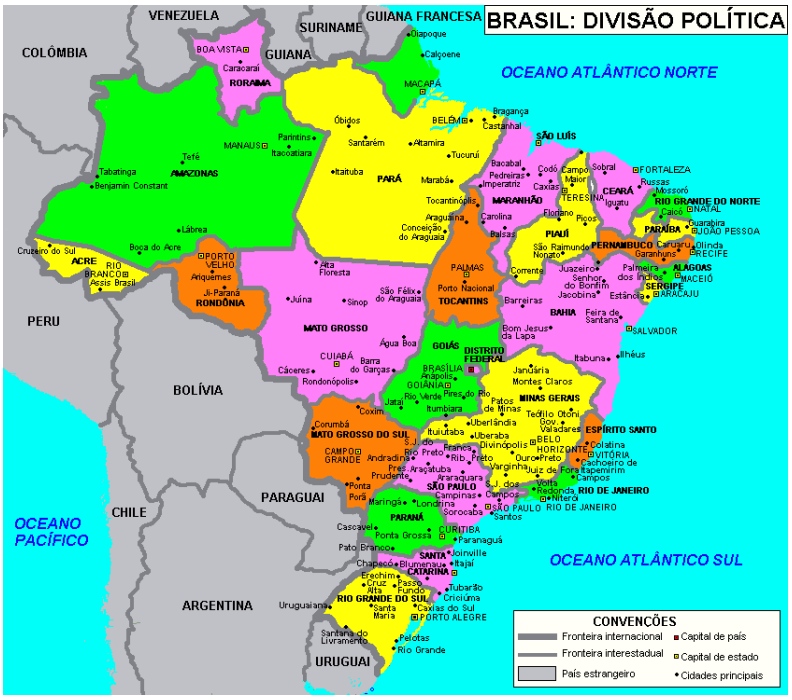
Nationwide averages for Internet penetration conceal wide differences in access, being higher for urban than rural areas, richer people, more educated people, and more developed states.

Brazil is the largest and arguably the most important country in Latin America (Figure 1). With an estimated population of 209 million in July 2018, it is also the most populous. In 2017 Brazil's economy was the ninth largest in the world according to the World Bank. Per capital income was US$9, 821 in 2017. The five largest cities are São Paulo, Rio de Janeiro, Brasília, Cuiabá, Fortaleza, and Belo Horizonte. There are 15 cities with over a million people, 40 cities of over 500,000 people, and 5,570 municipalities. With some 75 million people in the rural areas as defined by the Ministry of Agricultural Development, provision of affordable broadband to this group, which has the lowest average income levels, presents a particularly severe problem.

To help improve broadband coverage and reduce the cost of broadband access, the government launched a major broadband infrastructure development initiative, setting ambitious targets. Called the National Broadband Plan (*Plano Nacional de Banda Larga* – PNBL), the goal was to ensure that broadband access is available to low-income households, especially in areas that have so far been poorly served. But the federal government allocated only limited financial resources to the PNBL, and the telecommunications sector remains the most highly taxed in Brazil at some 43% of net income. Many States created strategic plans for broadband and eGovernment and are implementing the projects in these plans. Most state Governors understand that they need to modernize their government secretariats and agencies, and to support them with a modern information infrastructure so they can become transparent and nimble, focused on producing

excellent public services in essential areas, such as public safety, education, health, and welfare. These states are creating public and private partnerships to help achieve these goals.

Figure 1: Political Map of Brazil



But Brazil has only begun recovering from a deep recession caused largely by poor macroeconomic management during the past two federal administrations. The new administration that took office in January 2019 is committed to market-oriented economic reforms including social security, taxation, and bureaucracy reduction.

Despite receiving considerably less investment resources than announced on various occasions by government official (that can be considered a sign of less than urgent priority for the PNBL), Telebras, a federal telecom operator, has gradually created a national network of fiber optic cables, in large part through public-public and public-private partnerships that involve leasing or exchanging existing dark fiber. The growth of the Telebras network has increased competition and thereby led to lower prices offered by private providers. Expansion of high-speed connections has been spurred by growth in demand for Internet access by the emerging lower middle class.

For primary and secondary education, beginning in 2008 telecommunications operators were required to provide broadband connections at increasing speeds to all urban public schools. This was obtained at virtually no budgetary cost by the so-called "exchange of obligations" agreed in April 2008 whereby the operators were relieved of the requirement to provide thousands of outmoded Telecommunication Services Posts with public phone booths, fax machines and Internet-connected computers. By 2014 all 62, 925 urban public schools had free broadband connections, though the quality and speed of the connections still left much to be desired.

A growing number of states, such as Ceará, Pará and Rio Grande do Sul, have built their own terrestrial networks making use of various kinds of partnerships, usually with the National

Education and Research Network (*Rede Nacional de Ensino e Pesquisa* – RNP), electric power distributors, and companies such as Petrobras and Vale that own fiber networks of their own. There objectives have been to reduce costs of connectivity and reach previously underserved or unserved residents.

In 2005 RNP began a program to build fast metropolitan fiber optic networks in Brazil's major cities in association with a variety of partners. This program is called Redecomep, and as of June 2019 had 40 metropolitan networks in operation with some 2,000 km of fiber optic cables. Redecomep achieved this by partnering with electric power companies, state and municipal governments and other entities that provided rights or way, ducts or poles in return for access to fibers in these cables.

The Ministry of Science, Technology, Innovation and Communication (MCTI) finances fiber optic cables and equipment for operation of the fibers in these cables that serve academic and research institutions. But the number of pairs of fiber in these cables is much larger than needed for the academic and research institutions, allowing allocation to other partners that provide services in kind or for direct leasing payments. For example, metros, light rail lines, urban toll roads, and state and municipal governments can offer rights of way and ducts. Electric power companies can provide poles on which the cables can be hung. And Telebras can offer fibers in its backbone network.

In Ceará the state ICT Company, ETICE, has built a 3,000-kilometer ring of fiber optic cables around the state that, with its wireless extensions, reaches 88 percent of the state's population. Called the Digital Beltway (*Cinturão Digital do Ceará - CDC*), its nucleus is Gigafor, co-financed by RNP's Redecomep program in the state capital, Fortaleza. At various points along the fiber trunk lines there are towers from which municipalities not connected to CDC fiber, can connect through wireless links, allowing them to communicate with the state government and other municipalities. In 2015 ETICE held a public auction of dark fibers in the CDC using a RFP designed with USTDA-funded technical assistance, a project on which Peter Knight worked. A consortium of Ceará-based ISPs won the right to a lot of fibers. The income from the lease of these fibers covers all of ETICE's operating costs, making the company independent of the state budget and contributing to the expansion of private sector ISPs in Ceará. There are plans to expand the CDC to reach more interior points in the state as part of contracts to be signed with future private sector partners to be selected in new auctions using the improved RFP design and through the RNP's *Veredas Novas* program.

A similar program called Navegpará exists in the state of Pará. H&A's 2016 Definitional Mission recommended that a feasibility study that would expand the Navcgapará network using both fiber and radio extensions be financed, and Astro Systems won the contract to carry out that study.

In Paraná the state government has used another means to build a state network, namely purchasing bandwidth from Copel Telecom, a subsidiary of the state electric power company. Copel Telecom has an extensive fiber optic network launched in 2010 that now reaches all 399 municipalities in the state. The network has over 30,000 km of fiber optic cables.

Rapid technological change and increased competition among providers of telecommunications services promoted by Brazil's successful privatization and liberalization of this sector have helped reduce the cost of connectivity, and many federal, state and municipal initiatives aim to provide free or low-cost wireless Internet service to low-income populations. Continued technological progress, the availability of free and open source software, and favorable financing terms have reduced the cost of computer equipment and software.

Brazil's new federal government is commitment to macroeconomic stability and market-oriented

reforms that should accelerate Brazil's growth despite the high tax burden that has made it difficult to increase public financial resources for ICT and eGovernment-related investments, including telecommunications and IT infrastructure, public digital inclusion programs, connectivity, distance education, eGovernment programs, and the like. Furthermore, the new government seeks to improve relations with the United States.

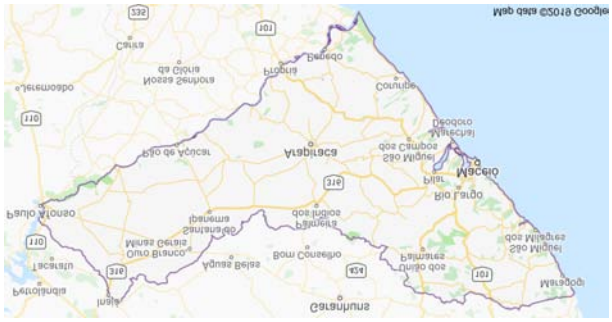
Equatorial Telecom's current service area

The states of Pará, Maranhão, Alagoas, and Piauí include major parts of the Amazon rainforest as well as transitional zones and part of the semi-arid Northeast region of Brazil (Figure 2).

Figure 2: Maps of Pará, Maranhão, Alagoas, and Piauí

Pará

Maranhão



Alagoas

Piauí

The states of Pará, Maranhão, Alagoas and Piauí occupy an area of 2.9 billion square kilometers, 33.5% of Brazil's total area. These states had an estimated population in 2018 of 22.1 million, or 10.6% of Brazil's. Their estimated per capita GDP in 2016 ranged from US$3,515 in Maranhão to US$4,783 in Pará. The total GDP for the four states that year was US$90.1 billion, or about 5% of Brazil's GDP. These states have a relatively flat landscape, ranging from large extensions of the Amazon rain forest to the semi-arid interior of Alagoas and Piauí,

These states have a diverse economy, including agricultural activities, industry, mining (especially in Pará where the huge Carajás mining complex is located), tourism and services.

Equatorial Telecom

Equatorial Telecom (ET) is the telecommunications sector company of the Equatorial Energia (EE) Group which, in turn, is a holding company operating in the Brazilian electricity sector in the

generation, transmission and distribution segments. In the electric power area, EE controls CEMAR (Companhia Energética do Maranhão), CELPA (Centrais Elétricas do Pará), CEPISA (Companhia Energética do Piauí) and CEAL (Companhia Energética de Alagoas), CEAL having been acquired from Eletrobras at the end of 2018. In the transmission segment, Equatorial Transmissão is also controlled by Equatorial Energia.

ET was created in 2012 to meet the Equatorial Energia Group's demands in the telecommunications area for the integration of its units and support for the distribution and operation of distributors, but only from 2018 onwards, it was structured to extend its operations to the general telecommunication market. The motivations for this structuring stem both from the lack of telecommunications services in the region and from enhancing the opportunity of Equatorial Energia Group investments in the Transmission segment, where the construction license for 2,586 km of transmission line in Brazil was obtained. which shall have the launch of optical ground wire (OPGW) cables, with 36 optical fibers to begin the development of a national telecommunications network.

Currently, ET is headquartered in São Luís, Maranhão state, and has branches opened in Belém, Pará and Teresina, Piauí, and is in the process of opening a branch in Maceió, capital of Alagoas. ET currently has a fiber optic network of approximately 1,300 km and provides services to approximately 220 points of customers in the market of Maranhão and Pará, and the Equatorial Energia Group is also its largest customer.

The services currently provided by the company are STFC (Fixed Telephony) with technology based on SIP, and multimedia communication services (SCM) with data link services and internet links to customers through fiber optic cables. ET has an average turnover of around R$1.3 million and estimates an EBITDA for December 2019 on the order of R$4.5 million.

B. The Project

The technical assistance project to be prepared by the US firm should cover the entire area of activity of Equatorial Telecom and its subsidiaries and shall have as main objectives:

- Analysis of the Telecommunications Market in the states of Pará, Maranhão, Piauí and Alagoas, by product segmentation and sector segmentation, including the analysis of the competition with the detailing of its areas of operation and positioning in the market;
- Business model by segment of telecommunications service to the market
- Network planning to serve this market in accordance with the demands and potentialities identified;
- Network expansion plan, based on market and return on investment;
- Definition of the resources needed to expand the network, with the evaluation of existing and necessary technologies for network deployment and indication of solutions and suppliers;
- Indication of the organizational structure and management model to be adopted in the company;
- Indication of computerized solutions to support the business and management and operation of the company;
- Indication of Marketing Plan for more effective action in the market;

- Pricing model of products and services and comparative analysis with that practiced by competitors in the local markets;
- Market positioning strategy, by service segment;
- Regulatory evaluation, both in the telecommunications area and in the energy area due to ET's strong connection with the Equatorial Energy Group;
- Definition of the platform and communication protocols to be used, and in case of complementary radio use, the definition of the frequency of operation of the telecommunication systems;
- Estimate of the investments and costs involved in the Project per phase established by the market and company evolution.
- Design and a network data center and backup facility.

Fiber optic network

The entities that shall participate and/or influence the project shall be: Equatorial Energia and its distribution concessionaires (CEMAR, CELPA, CEPISA and CEAL), Equatorial Transmissão and 55 Soluções; the National Telecommunications Agency (*Agência Nacional de Telecomunicações* - ANATEL); the National Electric Energy Agency (*Agência Nacional de Energia Eletrica* - ANEEL) and municipal and state governmental entities (state and municipal governments)

For the execution of all scope of the technical assistance project, ET estimates it shall take approximately 10 months from the time the contract with the US firm is signed. The implementation of the project shall take place immediately after the completion of the technical assistance project and shall follow according to the proposals formulated and the phasing adopted in the evolution of the company's business. The U.S. Firm chosen for this project shall interface with the U.S. firm selected under the Smart Grid Telecommunications Support Plan CEMAR USTDA-funded study. The latter firm is preparing a detailed inventory of all telecom assets and systems within CEMAR but also within all the other EE concessions. That U.S. Firm shall have compiled a thorough inventory of all the current and future IT and OT systems and their telecommunications needs so that report shall be extremely helpful to the U.S. Firm selected for the present study. Additionally, the U.S. Firm chosen for the EE project shall have produced a detailed report on the existing and future challenges for telecommunications integration within EE's IT Network and this report shall be invaluable to the U.S. Firm working on the ET study as that firm can use much of that same data in its technical Assistance. The U.S. Firm contracted for the ET study shall define and clearly describe the telecommunications integration issues and challenges that shall necessitate the implementation of new software and/or hardware systems.

Additionally the output of the report produced by the U.S. Firm working on the EE study, specifically the development of future demand scenarios for Grantee telecommunications services on an annual basis for a 15-year period with scenarios for high, medium and low economic growth scenarios shall be extremely useful for the U.S. firm working on the ET study.

The main challenges for implementation of the technical assistance project are the planning and choice of technologies for the telecommunications infrastructure desired by ET in its effort to market across its large territorial extension and climatological diversity.

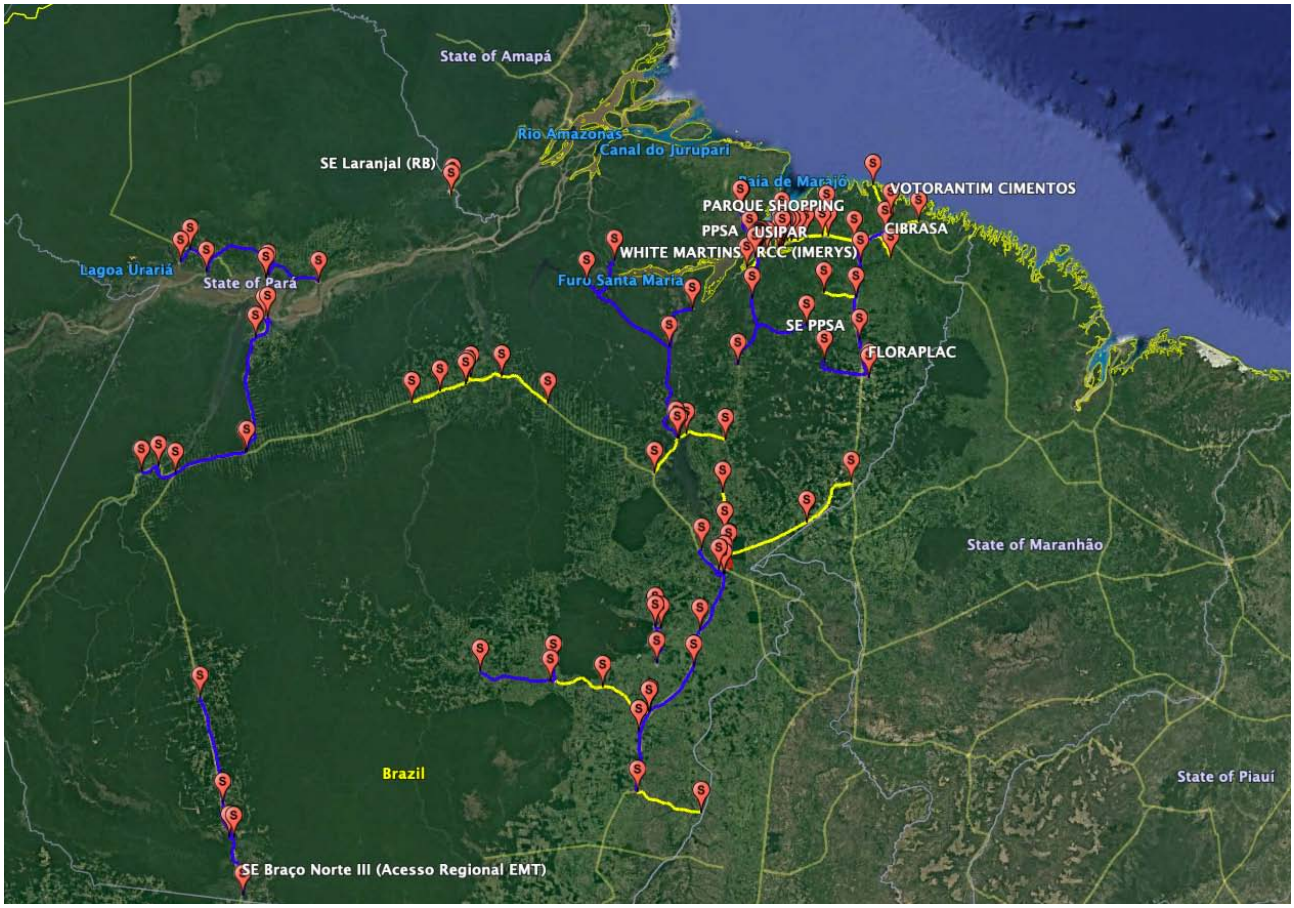
The technologies selected should provide the telecommunications infrastructure that would work best in the market and ones that best meet the needs of ET's customers, i.e., terms of technology, prices, and business promotion. These technologies include but are not limited to:

telecommunications network assets; IoT network solutions; mobile applications; hardware and software for business management, asset tracking and field team management; telecommunications network equipment (switches and routers); monitoring and sensing systems, among others.

The technical assistance project may be replicated in the expansion of the company in other Brazilian states as ET has regulatory authorization to operate throughout Brazil.

Figures 3 -5 show existing ET fiber optic networks in Pará and Maranhão. Figures 6 and 7 show planned ET fiber rings in Teresina, Piauí, and Maceio, Alagoas. And Figure 8 shows the ET's plan for a national fiber network.

Figure 3: Existing ET fiber network in Pará

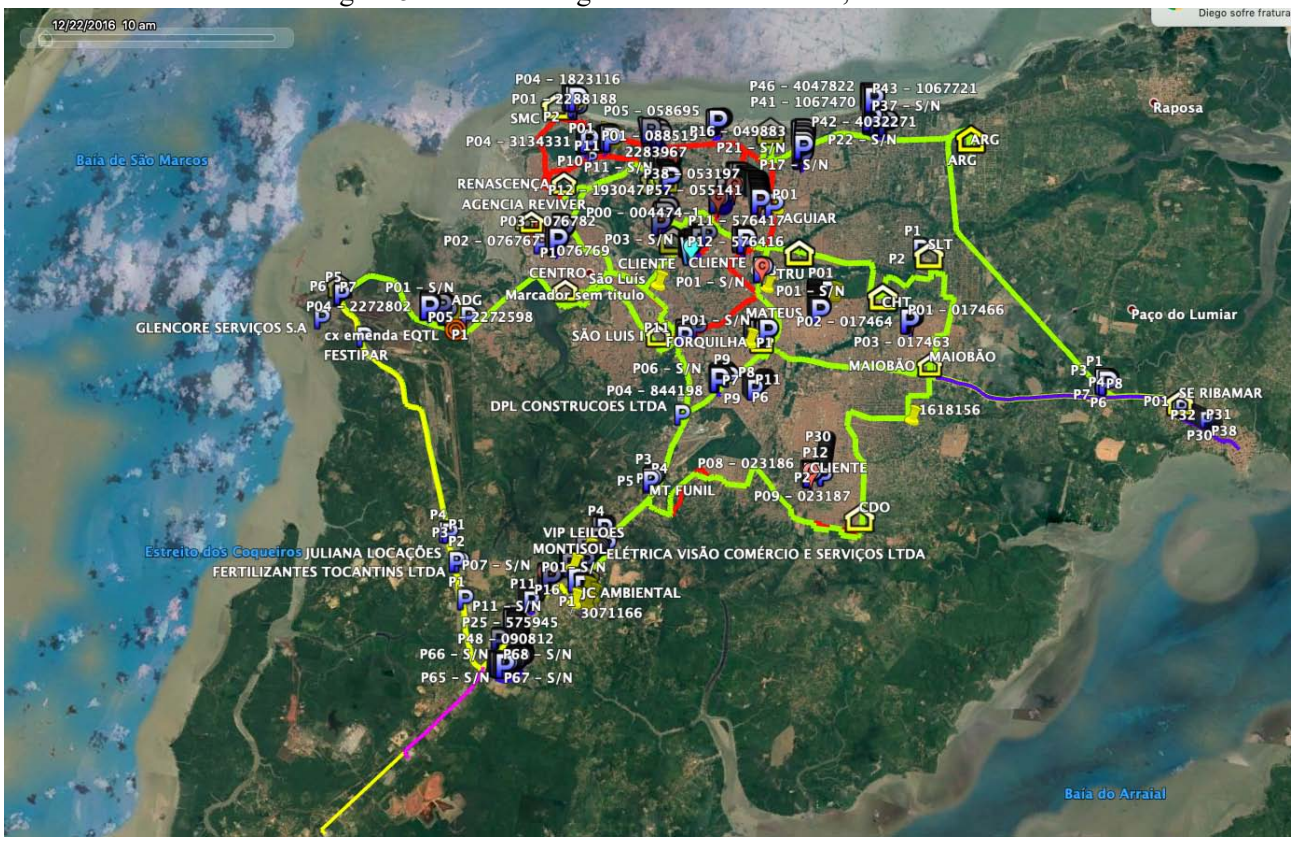


Source: ET

Figure 4: Existing ET Fiber Optic Network Connections in Maranhão

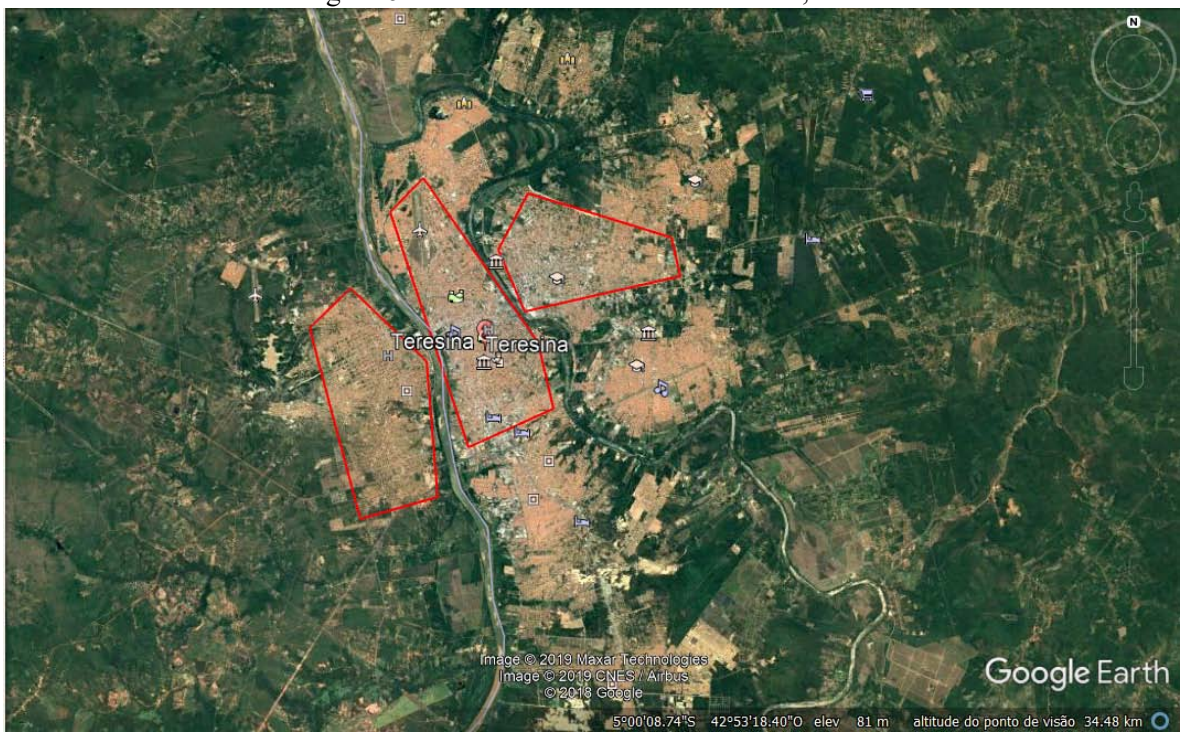
Source: ET

Figure 5: ET's Existing Network in São Luis, Maranhão



Source: ET

Figure 6: Planned ET Network in Teresina, Piauí

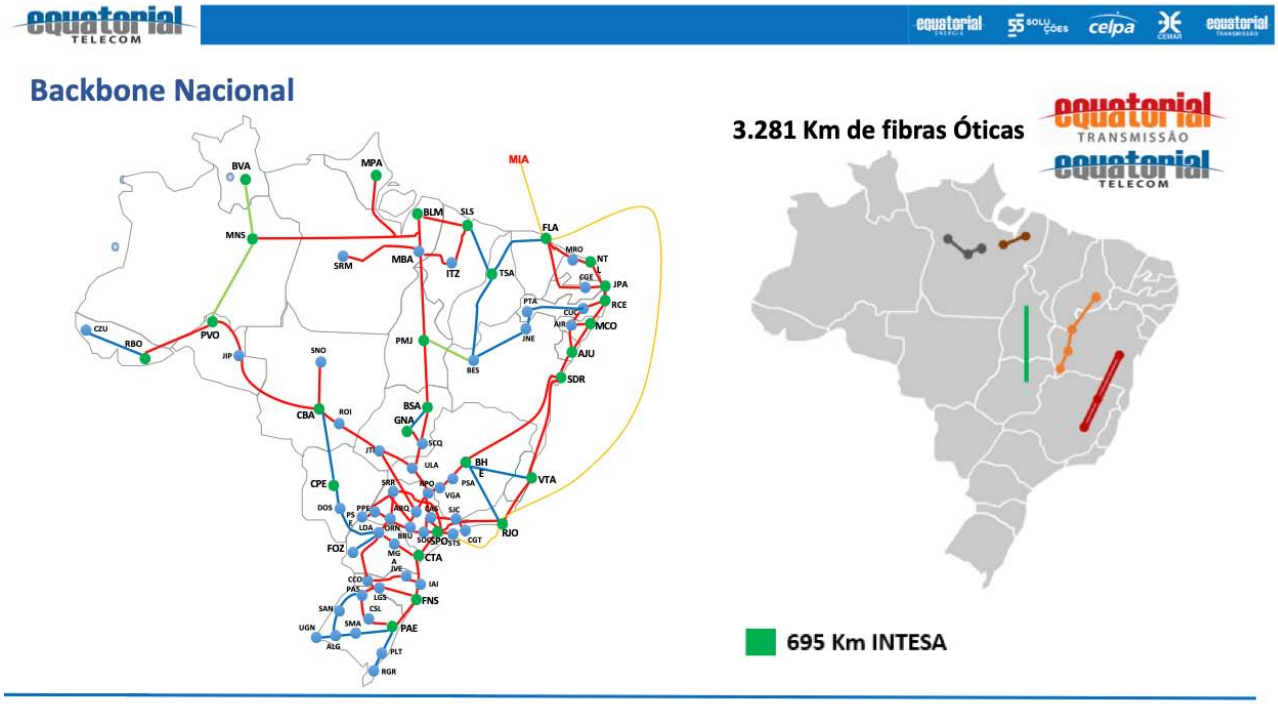


Source: ET

Figure 7: Planned ET Network in Maceio, Alagoas

Source: ET

Figure 8: Planned ET National Network



Source: ET

A basic economic characteristic of fiber optic networks is that the cost of increasing the numbers of fibers in a cable before it is deployed is much less than proportional to the number of fibers. Doubling the number of fibers increases the price of the cable from 30 to 40 percent. But the total cost per kilometer of the deployed cable increases much less, from 10 to 20 percent if aerial and less than 5% if underground, since the cost of hanging or burying the fiber is about the same irrespective of the number of fibers in the cable. When costs are shared among partners, usually in proportion to the number of dark (unlit) fibers to which each partner has rights, the result in a win-win situation, since each partner's costs are much less than if they had created their own fiber links. This provides a substantial incentive for the entity investing in the fiber link to find partners. Each partner usually "lights" its own pairs of fiber, though some other aspects of the infrastructure, like cabinets holding the electronic equipment, can also be shared.

Swaps are another way to reduce costs, and are widely used in the telecommunications industry between commercial telecommunications operators, though this fact is not widely known and it is extremely difficult to obtain maps showing each company's network and those parts that are shared or traded with other companies.[1] Several other Brazilian states, led by Pará and Ceará have invested in their own fiber networks and engaged in sharing of fiber cables with partners including RNP, Telebras, Petrobras, and federal and state electric power distribution companies. A number of other states have begun or are planning to do the same, among them Rio Grande do Sul, Santa Catarina, Sergipe, Piauí, and Tocantins.[2]

There are existing fiber networks in the states where ET plans to expand that are operated by RNP, Oi, Embratel, Eletronorte, PRODEPA, and Telebras. There are also several small and medium providers. There is thus the possibility of swaps or leasing of dark fiber with these fiber owners.

As part of its New Paths (*Veredas Novas*) program, RNP plans to put in fiber links to many *municípios* where there are research and higher education institutions outside the capitals of the four states. RNP is interested in collaborating with ET in a mutually supportive way, for example joint deployment of fiber optic cables, sharing and swap of fibers in networks, especially in RNP's metropolitan networks in the four states. RNP is in touch with ET for this purpose.

Datacenter and backup facility

ET has determined that the expansion of its fiber optic network shall require a dedicated data center and backup facility (either a second data center or use of cloud services) to support network operations and requests USTDA funded technical assistance to design the data center and backup facility.

In sum, ET seeks USTDA funding for an international consultancy to conduct a full feasibility study for the expansion of its fiber optic network, data center, and backup data center.

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[1] See Knight, Peter T. (May, 2014) *The Internet in Brazil: Origins, Strategy, Development, and Governance*. Bloomington, IN: Author House, especially Chapter 1, "The Strategic Importance of the Internet for Brazil's Development" for further analysis. A Portuguese language version of the book is also available.

[2] See *Ibid*, Chapter 5, "What Is Being Done to Improve Internet Connectivity". Also Carvalho, Feferman, Knight and Woroch, "Public-private partnerships for the expansion of access to broadband: lessons of Ceara's Digital Beltway", Chapter 13 in Knight, Feferman, and Foditsch, eds. (2016) *Broadband in Brazil: Past, present and future*. São Paulo: Figurati/Novo Século (free eBook in PDF format available from Google books). The Portuguese version was published in July 2016 and is available as an eBook in Kindle and Google Books.

III. GOVERNMENT COMMITMENT

There is no need for government commitment since ET is a private sector firm with the required telecommunications licenses from Anatel to operate anywhere in Brazil. ET has provided a letter of commitment indicating that it has the financial resources to deploy the fiber optic network and construct the specialized data center and backup facility and intends to proceed with these projects once the technical assistance studies are complete (Annex V).

IV. POSSIBLE SOURCES OF PROJECT FINANCING

ET assured the DM team that the project can be financed by the resources generated internally within the EE Group or by loans should this be more advantageous. Thus, there is no need to search for other sources of financing.

V. POTENTIAL FOR US EXPORTS AND FOREIGN COMPETITION

The cost of the fiber optic broadband network with some minor wireless extensions could be on the order of R$156 million (about US$41 million), with an export potential for US producers of hardware, software and services of some US$23 million for the network. The cost of the data center and backup facility is estimated at R$41 million (US$11 million) with an export potential of US$33 million. The total for the project is R$287 million (US$76 million) with an export potential of US$ 57 million (Table 2).

US firms are very strong in the ICT sector. Those who might bid on RFPs for this project include:

- American Tower (telecommunications towers)
- Cisco (Network Infrastructure),
- HP (servers and storage, and cloud services),
- Dell EMC (servers, storage, hyperconverged systems),
- Sun Oracle (Database, BI, Storage, Cloud services, hyperconverged systems like Exadata),
- Microsoft (Data center Software, Database, OS, and cloud services (Azure)),
- IBM (servers, application software, and cloud services),
- BMC: (Infrastructure software),
- CA Technologies: (Infrastructure software)
- Cloudflare (software)
- Xterra (SDN solutions, Optical networking platforms)
- Ciena (adaptive networks, merged with Blue Planet specialized in network virtualization, etc.)
- Ceragon (wireless backhaul equipment)
- Corning Optical Communications (fiber optic cables and connectors)
- Microsoft Azure (cloud services)
- Amazon Web Services (AWS),
- Google Cloud Services and software
- APC & Eaton (Power supply & Generation)
- Fortinet and Symantec (Security Systems & Software)

Other US firms that manufacture equipment that could be used in the project and might be interested in bidding include Corning (fiber optic cables and connectors), Brocade, Juniper, Force 10, and Extreme (high performance switches and routers); Supermicro (servers), Fusion IO (SSD Storage), Kingston (memory chips), Western Digital (storage); Emerson, Schneider, Chatsworth, APC, and ADC (data center components including power distribution, cooling, and fiber guides); AMD and Intel (CPUs and servers); Fortinet, McAfee, Norton e Symantec (anti-virus, network security); Clearfield (wireless and fiber broadband equipment); and Ubiquiti Networks, Streakwave, Netgear and Belkin (wireless broadband equipment). Despite increasing competition, especially from Chinese companies like Huawei and ZTE and for fiber optic cable, Furukawa (that has a factory in Brazil), US firms in the ICT sector are very competitive. Several US suppliers with Brazilian operations contacted by H&A are open to providing supplier financing: Cisco, Oracle, EMC, IBM, Dell, and Hewlett Packard. Most US suppliers have Brazilian subsidiaries, so market entry should not be an issue for them.

VI. FOREIGN COMPETITION AND MARKET ENTRY ISSUES

Potential foreign competitors could include

- Huawei: Network Infrastructure
- Lenovo: servers
- Hitachi: Storage
- NEC: Storage, servers, telecom
- Alcatel Lucent: Network
- ZTE: Network
- SAP: BI
- Siemens: Network
- Fujitsu: Network
- Kaperski: Security software

VII. PRELIMINARY DEVELOPMENT IMPACT REVIEW

The U.S. firm shall identify and assess the developmental outcomes that would be expected if the project is implemented in accordance with the recommendations of the study.

Development Impact Measures are designed to help quantify the impact of USTDA's support for infrastructure development in emerging economies. This information is essential to USTDA's ability to set clear goals and measure the results of its programs, relative to the Agency's core objective of promoting United States private sector participation in development projects around the globe. Understanding the local impacts of USTDA's program supports the Agency's ability to design projects with a higher likelihood of implementation and a higher likelihood of U.S. export generation, thus supporting the Agency's mission.

Development Impact Measures should be viable, realistic and quantifiable. H&A evaluated development impact indicators from a list provided by USTDA At least one realistic and quantifiable Development Impact Measure was selected for each USTDA activity. At least one realistic and quantifiable Development Impact Measure was selected for each USTDA activity. In close consultation with the proposed project sponsor, a baseline measurement was established for each indicator, which shall be used to compare future outcomes.. The baseline is also used to set an anticipated timeline and determine how the information shall be measured and collected once a project moves to implementation. This baseline information is incorporated into the Terms of

Reference, which provides reporting guidance to the U.S. firm performing the USTDA activity. ET selected the following indicators.

All	Promoting Effective Markets and Governance	Promoting Competition	Implementation/utilization of USTDA recommendations led to opening of market to greater competition or introduction of standards (elimination or reduction of threat to foreign business interests and	Y/N*
Telecom	Infrastructure Development and Efficiency Gains	Improved Digital Communication Access	Number of people affected by expansion in telecommunications infrastructure to both metropolitan and rural areas including Broadband, Wireless, Voice, and Data (particularly of note if reaching populations without prior access to internet, telephone, etc.)	Number of individuals
Telecom	Infrastructure Development and Efficiency Gains	Improved Data Management and Security	Capacity added, security/redundancy gained, or reliability improved through implementation of data centers, cloud computing systems, or other storage infrastructure	Y/N*

The U.S. firm selected shall update the indicators chosen and anticipated measurable outcomes, based on the recommendations resulting from the USTDA Activity. The consultants shall then incorporate the baseline analysis and adjust the findings, as needed, to explain how the proposed activity shall directly impact development in Brazil. The U.S. firm shall work closely with the project sponsor as well as USTDA personnel at this stage to ensure that the final report for the activity clearly displays the anticipated outcomes to be achieved when the project is implemented. These updates shall be used in future evaluation efforts to monitor progress and expected timeframes when the development impact shall be realized

VIII. EVALUATION STRATEGY

In addition to the following benchmarks to evaluate the success of the project the FS/TA U.S. firms shall also address the following questions within the Evaluation Strategy:

1. The proposed project implementation timeline;
2. How shall the project be developed (Engineering, Procurement and Construction, Turnkey, Build-Own-Transfer, Build-Own-Operate, etc.);
3. Any potential difficulties ET might encounter during project implementation and how can these challenges be mitigated.
4. What regulations, if any, should be in place before the project can be implemented; and
5. What other entities must authorize or approve the project for implementation.

Benchmarks to help USTDA evaluate success of project

- Financing for project is obtained. The amount from each source should be specified.
- Issue of RFPs for purchase of software and equipment with international competitive bidding, in months from date finance approved. This is a complex process in Brazil and sometimes takes months. The faster it is accomplished, the better managed is the state and the executing agencies.
- Bids received and winners selected. Metric: the percentage of total won by US firms
- Purchases completed. Metric; time in months from selection of winning bids.
- Percentage of total software and equipment purchased provided by US firms
- Construction and equipping initiated. Metric: time in months from purchase of equipment.
- Construction and equipping completed. Metric: time in months from the initiation of construction.
- Full planned network and data centers in operation. Metric: time in months from completion of construction. Includes time for installing software and testing.
- Number of partners sharing costs of ET's network and extent of cost reduction compared with ET undertaking all investments and operational costs itself. Divide into capital and current costs.

Proposed project implementation timeline

Stage	Objective	Months to Execute
1	Signing of Contract with USTDA	4
2	Preparation of the U.S. firm's consultancy reports for the network and data centers	6
3	Preparation of RFPs (*editais*) for equipment, software, and services	4
4	Bidding process including selection of winners	4
5	Acquisition of fiber optic cables and equipment to reach 11 pole *municípios*	15
6	Acquisition and installation of datacenter equipment and software	6

- According to this timetable the data center should be operational in 24 months from the time the project bids are received, the broadband network in 33 months.

Potential difficulties

- Changes in ET management team that result in poorer project management
- Unfavorable changes in government policies

Other entities needed to approve project

- For domestic financing, approval BNDES and any domestically approved suppliers' credits. For new international operations (e.g. loans by the IADB or IBRD), approval by Federal authorities: Ministry of Planning (*Comissão de Financiamentos Externos* – COFIEX), STN with validation by PGFN, and finally by the Federal Senate.

IX. ENVIRONMENTAL IMPACT – CLIMATE RESILIENCE

A climate resilience assessment looks at the impact of climate on a potential project and involves two phases: (1) screening and (2) in-depth analysis. Screening identifies potential climate risks, vulnerabilities, and opportunities pertaining to a program or investment, determines if additional analysis is required, and if so, helps to scope that analysis. In other words, it is intended to either identify what further study is required or determine that further analysis is not warranted.

Where needed, in-depth analyses evaluate relevant technical, social, economic, and political aspects of climate risks, uncertainties, and design options. They produce recommendations on how to address the climate risks identified, both in the short term and the long term.

The DM Consultants along with senior staff in ET reviewed USTDA's Climate Resilience requirements for screening and in-depth analysis and determined that an in-depth analysis is not warranted..

X. IMPACT ON US LABOR

The impact on US labor would be negligible or positive. For broadband networks, there is no displacement of US facilities. Thus, the impact on US labor is expected to be positive to the extent that US-based firm provide equipment, software and services produced in the US.

XI. JUSTIFICATIONS & RECOMMENDATIONS

As this report has documented, ET's expanded fiber optic network and datacenters shall have high developmental impact in the states included in the expansion project by supporting enhanced competition in the provision of broadband internet connectivity, hence reducing the prices for such connectivity. The fiber network shall allow improved delivery of eGovernment services throughout these states and promote private sector development. The project may also be a tool for developing an integrated governance systems to link various state government offices in the ET operations area, providing greater speed and efficiency in the delivery of public services and thereby reducing costs to the state governments through the use of an efficient multiservice communications infrastructure.

The project shall also have a social impact. The population shall gain access to broadband Internet connectivity, allowing more citizens and enterprises to access the Internet, educational opportunities, and eGovernment services.

The project shall directly benefit U.S. companies that win contracts to provide goods and services needed in the project. It shall also help create partnerships between ET and US IT companies by bringing proven private sector solutions to the challenges that ET faces. This project meets USTDA's goals of providing technical assistance in cases where that assistance helps create partnerships based on the premise that private sector experience, technology, and ingenuity are integral to development and project sustainability.

Moreover, the involvement of a U.S.-based Consultant Team in carrying out the proposed feasibility studies should work to the advantage of U.S.-based suppliers of telecom and IT solutions, such as Cisco, Corning, Dell EMC, HP, VMware, IBM, Sun Oracle, and Microsoft. These suppliers are strong in the major technological areas but face growing competition from foreign suppliers.

Accordingly, H&A believes that funding of the feasibility study for ET would represent a good use of USTDA resources.

XII. QUALIFICATIONS OF PROFESSIONALS IN EQUATORIAL TELECOM BROADBAND NETWORK PROJECT

Our analysis has shown that we would require 12 staff for this project, including a Team Leader and Project Coordinator. Below are specific descriptions for each of the staff H&A is recommending.

Team Leader

- At least Ten (10) years of experience in the ICT industry
- Strong background in at least one of major areas of the feasibility study (hybrid fiber optic and wireless broadband networks, economic and financial project analysis)
- Management, organizational, and cross-cultural skills and perspective to structure, oversee, and carry out the Feasibility Study effectively
- Ability to communicate findings effectively and to liaise appropriately within ET and with other stakeholders
- Detail-oriented and able to prioritize
- Experience analyzing the development impact of ICT projects
- Experience serving in technical consultative role
- Excellent written and verbal communication skills, including technical writing
- Excellent ability to clearly explain advanced technical issues in a manner easily understood
- Strong interpersonal and customer service skills
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams
- Portuguese language skills, written and spoken is strongly preferred

Senior Economist

- At least a master's degree in economics or an MBA Degree
- A minimum of ten (10) years of experience in economic analysis of telecom projects
- Experience with pricing, costing, and business modelling of infrastructure projects
- Significant experience with market and competition analysis

- Detail-oriented and able to prioritize
- Experience serving in technical consultative role
- Excellent written and verbal communication skills, including technical writing
- Excellent ability to clearly explain advanced technical issues in a manner easily understood
- Strong interpersonal and customer service skills
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams
- Portuguese language skills, written and spoken is strongly preferred

Junior Economist

- An MBA Degree focused on organizational analysis and restructuring of organizations or at least a master's degree in economics with a focus on business analysis, financial analysis, organizational restructuring, and other related issues
- A minimum of five (5) years of experience in economic analysis
- Significant experience with market and competition analysis
- Detail-oriented and able to prioritize
- Experience serving in technical consultative role
- Excellent written and verbal communication skills, including technical writing
- Excellent ability to clearly explain advanced technical issues in manner easily understood
- Strong interpersonal and customer service skills
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams
- Portuguese language skills, written and spoken is strongly preferred and if sourced locally then fluency in English language, written and oral.

Financial Analyst

- An MBA Degree with a concentration in financial analysis or least a master's degree in economics with a concentration in financial analysis
- At least five (5) years of experience in financial analysis
- At least five (5) years experience with corporate finance and in developing financial business models and plans
- At least five (5) years of experience in cost accounting, statistical analysis, and in financial planning and strategy
- At least five (5) years of experience in analyzing and interpreting financial data and making comparative analyses
- At least five (5) years of experience in analyzing financial data and in creating financial models
- At least five (5) years of experience in cost analysis of network expansions; establishing and enforcing policies and procedures; providing trends and forecasts; explaining processes and techniques; and recommending actions to control costs
- Strong interpersonal and customer service skills
- Excellent ability to clearly explain advanced technical issues in a manner easily understood
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams

- Portuguese language skills, written and spoken is strongly preferred and if sourced locally then fluency in English language, written and oral.

Senior Telecom Engineer

- A post-graduate degree in electrical engineering or related field
- At least ten (10) years of experience in the telecom/ICT industry, including extensive experience with fiber optic networks, wireless network design, and operation of these networks
- Experience in defining and monitoring service level agreements (SLAs) for ICTs.
- Detail-oriented and able to prioritize
- Experience serving in technical consultative role
- Excellent written and verbal communication skills, including technical writing
- Excellent ability to clearly explain advanced technical issues in a manner easily understood
- Strong interpersonal and customer service skills
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams
- Portuguese language skills, written and spoken, preferred

Junior ICT/Network Engineer

- At least an undergraduate degree in electrical engineering or a related discipline
- At least five (5) years of experience in the ICT industry including hands-on experience with the design, operation and maintenance of fiber optic networks and wireless extensions of such networks
- Experience in defining and monitoring service level agreements (SLAs) for ICTs.
- Substantial knowledge and experience with AutoCad or related software used to design networks
- Detail-oriented and able to prioritize
- Experience serving in technical consultative role
- Excellent written and verbal communication skills, including technical writing
- Excellent ability to clearly explain advanced technical issues in a manner easily understood
- Strong interpersonal and customer service skills
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams
- Portuguese language skills, written and spoken preferred

Security Expert

- A post-graduate degree in electrical engineering or related discipline
- Specialization in broadband network and infrastructure security
- Detail-oriented and able to prioritize
- Experience serving in technical consultative role
- Excellent written and verbal communication skills, including technical writing
- Excellent ability to clearly explain advanced technical issues in a manner easily understood
- Strong interpersonal and customer service skills
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams

- Portuguese language skills preferred

Senior Data Center Electrical Engineer

- Post-graduate degree in electrical engineering or related discipline
- At least ten (15) years of experience in the telecom/ICT industry, including hands-on experience with datacenters and outsourcing contracts for datacenters
- At least five (5) years of experience in defining and monitoring service level agreements (SLAs) for ICTs
- Expertise in the economic and financial analysis of projects and feasibility studies involving rapid technological change, including total cost of operations (TCO) and return on investment (ROI) analysis
- Detail-oriented and able to prioritize
- Experience serving in technical consultative role
- Excellent written and verbal communication skills, including technical writing
- Excellent ability to clearly explain advanced technical issues in a manner easily understood
- Strong interpersonal and customer service skills
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams
- Portuguese language skills, written and spoken, preferred

Junior Data Center Electrical Engineer

- At least an undergraduate degree in electrical engineering or related discipline
- At least five (5) years of experience in the telecom/ICT industry, including hands-on experience with datacenter design and implementation
- Knowledge of configuration management, problem management, change management, help desk, distribution and control of software, managing of service levels (SLM), capacity management, contingency planning, availability management, and cost management – as applied to datacenters
- Expertise in the economic and financial analysis of projects and feasibility studies involving rapid technological change, including total cost of operations (TCO) and return on investment (ROI) analysis
- Detail-oriented and able to prioritize
- Experience serving in technical consultative role
- Excellent written and verbal communication skills, including technical writing
- Excellent ability to clearly explain advanced technical issues in a manner easily understood
- Strong interpersonal and customer service skills
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams
- Portuguese language skills, written and spoken is preferred

Brazilian Legal/ Regulatory Specialist

- At least five (5) years of experience in elaborating and/or analyzing national ICT strategies from technical, economic, and social perspectives
- Substantial experience in working with both ANEEL and ANATEL on infrastructure projects

- Knowledge of Brazilian telecommunications legislation and regulations demonstrated by publications and employment record
- Detail-oriented and able to prioritize
- Experience serving in technical consultative role
- Excellent written and verbal communication skills, including technical writing
- Excellent ability to clearly explain advanced technical issues in a manner easily understood
- Strong interpersonal and customer service skills
- Strong sense of personal responsibility and accountability for delivering high quality work
- Ability to work well both independently and on teams
- Excellent ability to clearly explain advanced technical issues in manner that is easily
- Fluency in English Language, both written and oral

Brazilian Environmental Expert

- Post-graduate degree in environmental engineering or related discipline
- At least five years of experience with applying Brazilian environmental legislation in project analysis, including in the Amazon region;
- Knowledge of environmental impact of telecommunications projects
- Knowledge of Brazilian telecommunications and electricity regulations related to infrastructure project and fiber networks
- Strong English language skills, written and spoken is required

Brazilian Project Coordinator/Local Manager

The responsibilities of the Project coordinator include, but are not limited to, the following:

- Basic support logistics for everyone on team and their support people to ensure a smooth running of the project, such as deliverable coordination (formatting, timeliness, and other coordination)
- Travel coordination
- Familiar with Business environment within Brazil
- Team Leadership capabilities
- Arranging team meeting with the client in person and by telephone
- Managing and editing of deliverables, thereby ensuring that the deliverables closely follow the scope of work outlined and that there are no surprises
- Reviewing, coordinating and distributing any presentation materials, both the electronic and paper versions of presentations
- Developing and creating a library of resource material so that all consultants have easy access to any resource material, 24 x7, maintaining the library
- Arranging housing and payments for project related expenses
- Coordinating with Project Manager on Project Finance issues such as expense payments, consultant time
- Arranging logistics
- Fluency in written and spoken Portuguese and English is required

XIII. TERMS OF REFERENCE

Equatorial Telecom Broadband Backbone and Business Model

These terms of reference ("Terms of Reference") in this Annex I set forth the terms, conditions, provisions and specifications for the performance of the technical assistance ("TA") for the benefit of Equatorial Telecomunicações S.A. (the "Grantee" or "Equatorial Telecom"). The U.S. firm selected to perform the TA (the "U.S. Firm") shall perform the TA in accordance with these Terms of Reference pursuant to this Agreement of Understanding between the U.S. Firm and the Grantee, of which Agreement of Understanding this Annex I is a part.

The U.S. Firm's delivery of the TA must comply with the entirety of these Terms of Reference, and any modification of or deviation from these Terms of Reference must be approved in writing by USTDA in accordance with the procedures for amendments or other modifications under this Agreement of Understanding. The U.S. Firm acknowledges and agrees that (i) any performance by the U.S. Firm of work not included in, or not in compliance with, these Terms of Reference, or any failure by the U.S. Firm to perform any work set forth under these Terms of Reference (in compliance with those terms), will be ineligible for approval or payment, absent an amendment or other modification in accordance with such procedures, and (ii) failure to obtain prior written approval from USTDA for any modifications or deviations from these Terms of Reference may result in forfeiture of payment for work performed that is not in compliance with these Terms of Reference and/or a significant delay in payment of the final invoice.

Equatorial Telecom seeks to expand its fiber optic network and to invest in a new data center and back-up facility (and/or cloud storage) to support the expanded network and services (the "Project"). The objective of the TA is to enable Equatorial Telecom to implement this Project, including through detailing an investment plan, identifying prospective investment partners and developing a business model for operating the network. The TA would also develop designs and specifications for the new data center and back-up facility (and/or cloud storage). Equatorial Telecom is the telecommunications sector arm of Equatorial Energia Group.

The U.S. Firm shall undertake a quality control review process, including a technical and editorial review, of all deliverables and documents submitted to the Grantee to ensure readability, accuracy, and consistency. All deliverables and documents shall be submitted in draft form to the Grantee for review and comment prior to finalization. The deliverables specified in these Terms of Reference shall serve to keep the Grantee informed about the U.S. Firm's work on the TA and to ensure that the U.S. Firm's work is performed satisfactorily, in accordance with applicable Agreement of Understanding provisions and the terms and conditions of the USTDA Grant Agreement (per Clause G of Annex II of the Grant Agreement). All deliverables and the Final Report shall be submitted in English and Portuguese.

Any meetings or other actions or work set forth under these Terms of Reference that are indicated to occur in-person, on-site or otherwise in a specified location may, if agreed by both the Grantee and the Contractor (and with advance notice to and written agreement from USTDA), be conducted remotely, including online, by teleconference, by videoconference, or by other means, provided that the Contractor shall clearly document in the corresponding deliverable report the date on which

such agreement was reached and approved by USTDA, and shall describe the alternative means of accomplishing the relevant work, along with the rationale for such decision.

Further, if the Grantee and the Contractor propose to apply such a change to any tasks or subtasks in part (i.e., to change portions of a task/subtask from in-person to remote, while maintaining other portions as in-person, including the "breaking up" of a task or subtask in order to separate remote from in-person work), then: (i) the Grantee and/or the Contractor shall notify USTDA in advance of such a proposal, and USTDA may, in its discretion, approve of such proposal and formalize the proposed modification through an implementation letter to the Contract; and (ii) USTDA may, at its discretion, modify the Payment Schedule under the Contract in order to separate such remote and in-person work into separate payments, as appropriate, again through an implementation letter to the Contract. Notwithstanding the foregoing under this paragraph, USTDA reserves the right to make any appropriate adjustments to the total Grant Amount (and therefore the Contract value) that may result from any such modifications.

TASK 1: DATA COLLECTION

The U.S. Firm shall (i) conduct a review of the relevant literature on state-of-the art optical ground wire (OPGW)-based networks (reviewing at least four Brazilian and four international case studies), and (ii) research past and current Brazilian private sector, state and federal government initiatives in the planning, financing, construction, technology, and operation of municipal, state-wide and national broadband networks, and data centers, including security and emergency arrangements. In analyzing each of these Brazilian and international examples, the U.S. Firm shall identify, analyze and detail the best practices in technology, finance, construction and operation.

The U.S. Firm shall devote particular attention to business models that include infrastructure sharing under different leasing, exchange of rights for use of infrastructure, including fiber optic cables, towers, poles and ducts.

The U.S. Firm shall develop a preliminary work plan and schedule for the completion of these Terms of Reference. The preliminary work plan and schedule described in this Task shall be consistent with these Terms of Reference, and, in the event of any inconsistency, these Terms of Reference shall prevail. At least seven (7) calendar days prior to the U.S. Firm's initial visit, the U.S. Firm shall deliver the preliminary work plan to the Grantee for review and approval.

The U.S. Firm shall obtain and review all deliverables from Celplan Technologies, Inc. produced under the USTDA-funded Technical Assistance for a Smart Grid Telecom Support Plan for CEMAR (an entity owned by Equatorial Telecom's parent company, Equatorial Energia Group).

> **Deliverable #1:** The U.S. Firm shall prepare a report detailing all work performed under Task 1, including a preliminary workplan and schedule, and the case studies and best practices identified and recommended for the OPGW-based network and data center.

TASK 2: KICK-OFF MEETINGS, ASSESSMENT OF CURRENT SITUATION AND NEEDS/REQUIREMENTS ANALYSIS

The U.S. firm shall familiarize themselves with the Grantee's network infrastructure, Brazilian private and public sector finance, and conduct an analysis via Internet research and any documents provided by Equatorial Telecom.

The U.S. Firm shall meet with Celplan Technologies, Inc., the U.S. company carrying out the USTDA-funded Smart Grid Telecom Network Technical Assistance for CEMAR (a Maranhão-based subsidiary of Equatorial Energia). The U.S. Firm shall review and discuss the proposed plans for building CEMAR's telecom network.

The U.S. Firm shall travel to São Luis, Maranhão to meet with Equatorial Telecom. The U.S. Firm shall discuss the preliminary work plan and schedule with the Grantee. Based on the meetings with the Grantee, the U.S. Firm shall make any agreed upon revisions to the Work Plan (it being understood that any revised work plan shall be consistent with these Terms of Reference) and timetable and prepare a list of any additional data needed.

FIBER OPTIC BROADBAND NETWORK

The U.S. Firm shall meet with potential partners in the Project: Rede Nacional de Ensino e Pesquisa (RNP), private sector telecommunications companies, and any other private or public sector entities that may be identified by the Grantee.

The U.S. Firm shall:

- Identify factors which would help Equatorial Telecom partner with other private sector companies, state ICT companies, RNP, or other entities;
- Conduct basic cost/benefit analyses for the expansion of the fiber optic network and possible wireless extensions, taking into consideration the needs of the Grantee's prospective partners and clients;
- Quantify the benefits in unit cost reduction and improved quality (using standard telecommunications network metrics) for broadband communications that can be achieved for all potential partners in the network; and
- Identify potential partners to share in the investment and operating costs through the rental of dark fiber or infrastructure (poles, ducts, cabinets, etc.)

DATA CENTER

While in São Luís, the U.S. firm shall:

- Meet with the Grantee and major stakeholders (with guidance from the Grantee) to gain additional insights into their needs, interests, and expectations;
- Visit Equatorial Telecom's current data center and conduct a needs and requirements analysis for the expanded data center and backup facility focusing on expected demand for

datacenter services to serve the needs of Equatorial Telecom's expanding fiber optic network and its clients over the next five years;
- Conduct a security analysis, both physical and electronic, of the current data center and determine the best options for software and hardware, to ensure the security and privacy of the information contained in the expanded datacenter and its backup facility;
- Quantify the benefits in unit cost reduction and improved quality for datacenter services that can be achieved with the proposed specialized data center and backup facility; and
- Analyze at least three options for operation of the data center and backup facility, including use of commercial cloud computing facilities for part or all of the data processing and storage needs.

Deliverable #2: The U.S. Firm shall deliver a work plan, a schedule, and a list of any additional data required from the Grantee. The U.S. Firm shall also prepare a report of all work performed under Task 2, including, without limitation, a Needs/Requirements Analysis report for the data center/backup facility, the fiber optic network and any recommended wireless extensions, as well as details of all meetings and site visits, and all relevant findings and conclusions.

TASK 3: DIMENSIONING AND ALTERNATE SCENARIOS

Based on the findings of Task 2, the U.S. firm shall:

- Project the Grantee's needs for data storage over the next five years and estimate the magnitude of data or cloud storage requirements;
- Develop two alternative scenarios for data storage, one involving some use of cloud services and one based on exclusive use of the proposed modernized data center and the new backup data center;
- Evaluate the cloud deployment option; and
- Consider expansion of one of the existing data centers.

In consultations with the Grantee, the U.S. Firm shall recommend an optimum strategy for the integration of the existing data centers and recommend a redundancy strategy utilizing the current storage capacity.

Deliverable #3: The U.S. Firm shall prepare a report on all work done under this Task, including summarizing the alternative strategies studied and recommendations for the optimum strategies for the data center, including various storage and cloud scenarios.

TASK 4: FIBER OPTIC NETWORK ARCHITECTURE

The U.S. firm shall:

- Analyze the findings from Task 3 and develop specifications regarding the architecture and design of the proposed expanded fiber optic network and any wireless extensions;
- Analyze the findings from the USTDA-funded technical assistance for a telecommunications network for CEMAR;

- Analyze the findings from the optimization and cost-benefit analysis deliverable from the USTDA-funded technical assistance study for CEMAR regarding potential telecommunications architecture;
- Develop precise and detailed engineering estimates of network designs, equipment needs and capacity, and resulting capital expenditure and operating costs; and
- Propose and draft service level agreement (SLAs) to specify degrees of redundancy, maximum response times to incidents, percentage of "up time" and other technical metrics for the fiber optic network and any recommended wireless extensions.

Deliverable #4: The U.S. Firm shall prepare a report on all work performed under this Task, including the network architecture.

TASK 5: DATA CENTER AND DATA STORAGE ARCHITECTURE

The U.S. Firm shall:

- Analyze the findings from Task 4 and develop specifications regarding the architecture and design (including software) of the datacenter, its backup data center, and any cloud storage options the Grantee may choose after reviewing the findings of task 4;
- Develop precise estimates of data center design including equipment needs and capacity, and resulting capital expenditure and operating costs; and
- Propose and draft service level agreements (SLAs) for the upgraded centralized datacenter.

Deliverable #5: The U.S. Firm shall prepare a report on all work performed under this Task, including the data center architecture.

TASK 6: ROLES AND RESPONSIBILITIES

OPGW NETWORK

The U.S. firm shall conduct a study of the roles and responsibilities of the various actors involved in the operation of the network, including at the legal, institutional, structural and service levels.

The study of the roles and responsibilities for the OPGW network shall address, at a minimum, the following issues/questions:

- What will be the role of each partner in the network?
- How will performance of the network be measured?
- How should partners share in Project costs, both CAPEX and OPEX?
- How should partners share the extra costs that will be needed if it is decided to expand the network more than was anticipated?

DATACENTER

The U.S. Firm shall conduct a study of the future roles and responsibilities of the various actors involved for the operation of the datacenter and backup facility, including at the legal, institutional, structural and service levels. The study of roles and responsibilities shall address, at a minimum, the following issues/questions:

- Who shall administer the data center and backup facility?
- How shall performance of the datacenter be measured?
- If there is another private partner, how should it be remunerated?

Deliverable #6: The U.S. Firm shall prepare a report on all work performed under this Task, including a report of the roles and responsibilities for the datacenter and fiber optic and OPGW network, including any wireless extensions.

TASK 7: TECHNICAL AND OPERATIONAL BEST PRACTICES

The U.S. firm shall provide a comprehensive list of equipment, technologies and other products or services that are required and/or recommended for the development of the Project, including infrastructure and human resource development. The U.S. firm shall also evaluate the existing internal human resources of the Grantee's current operations capable of supporting the Project. The U.S. firm shall provide a list of advantages and disadvantages of each product/service.

7.1 Cyber Security Threat Identification

The U.S. firm shall identify and document a comprehensive inventory of all IT and cyber security threats related to the Project and shall identify the people, process and technology assets that are required and/or recommended in order to mitigate/minimize all known cyber security threats. The U.S. Firm shall:

- Identify existing information technology services extended to private and public sector clients;
- Perform a gap analysis comparing the Grantee's existing information security services against the needs and expectations of the potential market; and
- Identify all regulatory issues governing the information technology market as well as personal privacy, security services, and data privacy laws pertaining to the Project and areas where the regulation has restrictions on the types of data that can be stored in third party data centers.

7.2 Best Practices

The U.S. firm shall provide the following best practices guidance to the Grantee:

- Facility Best Practices: The U.S. firm shall develop an operational best practices document that summarizes global best practices for construction and operation of state-of-the-art

~~defines the operational parameters required for efficient, reliable and secure operation of the~~ telecommmunications data center and backup facilities and fiber optic networks, including any recommended wireless extensions.

- Ongoing Training: The U.S. firm shall identify all training required and/or recommended to operate the network, data center, and backup facility.

Deliverable #7: The U.S. Firm shall prepare a report of all the work performed and findings under Task 7.

TASK 8: BUSINESS CASE AND ECONOMIC AND FINANCIAL ANALYSIS

The U.S. Firm shall prepare a financial model to estimate the cost of ownership and funding options for the Project. The U.S. Firm shall also develop a high-level cost of ownership and sensitivity analysis. The sensitivity analysis shall be suitable to guide the Grantee in deciding the number of priorities and objectives that can be accomplished, given the different budget scenarios.

The analysis of business models should present at least three viable options for the operation and maintenance of the fiber optic network, including leasing and/or exchange of infrastructure with partners such as RNP, telecommunications operators, state ICT companies and infrastructure providers, and shall include a discussion of the strengths and weaknesses of each alternative arrangement, including recommendations on the best option(s).

The U.S. firm shall review the deliverables from the USTDA-funded telecom infrastructure plan for CEMAR and incorporate relevant items from that technical assistance in this economic and financial analysis. The U.S. firm shall correlate financial analysis with technical and strategic deployment considerations.

BUSINESS & FINANCIAL ANALYSIS

8.1: Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) Budgeting

The U.S. firm shall develop a complete budget for the capital costs of the Project, including but not limited to building costs, possible network expansion costs, hardware costs and software costs.

8.2: Internal Rate of Return (IRR) Analysis

The U.S. firm shall develop an Internal Rate of Return analysis for the Project with 5- and 10-year time horizons.

8.3: Comparative Business Case

The U.S. firm shall develop a business case and a business plan for building and operating the network, for any possible network expansion, and for operating the data center using return on investment (ROI) analysis.

ECONOMIC ANALYSIS

The U.S. firm shall:

- Assess all aspects of the Project's feasibility (technical, economic, financial, political, legal and organizational) and their interrelations for the data center and fiber optic network;
- Develop a Business Continuity and Disaster Recovery Plan for the Project;
- Evaluate Total Cost of Ownership of the network, data center, and backup facility;
- Develop an Implementation Plan for the network, data center, and backup facility;
- Develop a Finance Plan for the network, data center, and backup facility; and
- Prepare economic scenarios.

Deliverable #8: The U.S. Firm shall deliver a report of all work performed under this Task, including the business, economic and financial analysis report and a report recommending the most effective structure and their supporting legal, economic and financial rationales.

TASK 9: PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

The U.S. Firm shall conduct a preliminary environmental impact assessment of the implementation of the data center and broadband network. At a minimum, the U.S. Firm shall:

- Include a preliminary environmental impact analysis, including compliance with federal, state, and municipal governments as well as the requirements of potential lending agencies, especially the World Bank, the IFC, and the IADB;
- Identify anticipated positive and negative environmental impacts from implementation;
- Recommend ways to maximize positive impacts and minimize negative impacts; and
- Identify any actions that must be taken in advance of implementation to satisfy environmental impact requirements.

Deliverable #9: The U.S. Firm shall prepare a report of all the work performed and findings under Task 9.

TASK 10: DEVELOPMENT IMPACT ANALYSIS

The U.S. Firm shall identify and assess the developmental outcomes that would be expected if the Project is implemented in accordance with the recommendations of the TA. Development Impact Measures are designed to help quantify the impact of USTDA's support for infrastructure development in emerging economies. This information is essential to USTDA's ability to set clear goals and measure the results of its programs, relative to the Agency's core objective of promoting United States private sector participation in development projects around the globe. Understanding the local impacts of USTDA's program supports the Agency's ability to design projects with a higher likelihood of implementation and a higher likelihood of U.S. export generation, thus supporting the Agency's mission.

At least one realistic and quantifiable Development Impact Measure is selected for each USTDA activity. In close consultation with the Grantee, a baseline measurement is established for each

indicator, which is used to compare future outcomes. The baseline is also used to set an anticipated timeline and determine how the information will be measured and collected once a project moves to implementation.

The Development Impact Report shall assess the baseline and actual values of the indicator listed below:

Category	***Indicator***	***Description***	***Anticipated Outcome***
Infrastructure Development and Efficiency Gains	Improved Digital Communication Access	Number of people affected by expansion in telecommunications infrastructure.	TBD (number of individuals)
Infrastructure Development and Efficiency Gains	Improved Data Management and Security	Capacity added, security/redundancy gained or reliability improved through implementation of data centers, cloud computing systems or other storage infrastructure.	*Y*

Deliverable #10: The U.S. Firm shall prepare and deliver a report of all work performed under Task 10, including (without limitation) the Development Impact Analysis, as described above.

TASK 11: PROJECT PLANNING AND IMPLEMENTATION

The U.S. firm shall assess and determine what the critical goals and success factors are for Project implementation and shall identify relevant risks and risk mitigation measures to achieve these goals/success factors. The analysis shall provide discussion and recommendations on how best to achieve the following outcomes:

- Equatorial Telecom shares the financial benefits (not just the costs) of the investments made as a result of the Project with any partners;
- Continual monitoring of the contractual conditions in relation to the market is carried out – provisions for this need to be incorporated in the contract itself;
- The objectives for any private or public sector partners (scope, service levels, metrics, requirements, etc.) of relevant contracts are clearly defined;
- Any need to make payments to public or private sector partners for strategic and critical activities outsourced is given due priority;
- Penalties for noncompliance with contract conditions are established and applied if violations are detected;
- A clear process is defined for exiting any relevant contract and for transitioning to one or more other public or private sector partners with operating responsibilities for the data center or sharing infrastructure of the hybrid broadband network; and
- Other critical success factors inherent in any outsourcing for ICT services and means to achieve them defined and a plan is in place for achieving such success factors.

The U.S. Firm shall also elaborate several evaluation criteria for USTDA to evaluate the successful implementation of the Project. These criteria shall include:

- Benchmarks to help USTDA evaluate success of the Project;
- Proposed Project implementation timeline;
- How the Project will be developed (Engineering, Procurement, Construction, Turnkey, Build-Own-Operate, Build-Own-Transfer);
- Likelihood of development;
- Potential difficulties that the Project Sponsor might need to overcome;
- Additional regulations that need to be in place; and
- Other entities that need to approve the Project.

The U.S. Firm shall prepare a Project Implementation Report, which shall include (i) a detailed recommendation concerning the most appropriate organizational and technological structure for the Project, and (ii) a detailed breakdown of the steps that need to be undertaken by the Grantee to implement the Project according to the recommended structure, including recommendations for handling any outsourcing or infrastructure sharing arrangements with private sector firms, state ICT entities, RNP and/or any other partners.

The U.S. Firm shall identify U.S. sources of supply for all goods and services required to implement the Project. In particular, the U.S. Firm shall list U.S companies that provide the technologies or services to be implemented. The U.S. Firm shall include detailed information about U.S. companies under the deliverables of this Task and in the Final Report, including potential products/services, a point of contact in Brazil if available, or where sales to Brazil are managed. The business name, point of contact, address, telephone and e-mail address shall be included for each commercial source.

Deliverable #11: The U.S. Firm shall prepare a report of all the work performed and findings under Task 11, including a Project Implementation Report and a Sources of Supply Report.

TASK 12: DRAFT FINAL REPORT

Upon concluding all tasks listed above, the U.S. Firm shall travel to São Luís to formally present to Equatorial Telecom the findings and recommendations and a near-final version of the Final Report (as defined under Task 13). The Grantee will be able to use this opportunity to ask questions or provide further comments and suggestions based on the presentation and draft of the Final Report. To support the presentation of the TA the U.S. Firm shall:

- Create an accompanying PowerPoint presentation; and
- Identify any additional suggestions or recommendations derived from the Grantee's responses to the presentation

Deliverable #12: The U.S. Firm shall present the draft Final Report and PowerPoint Presentation.

TASK 13: FINAL REPORT

Once the Grantee has provided comments and revisions to the draft Final Report, the U.S. Firm shall make the necessary changes and modifications to the draft Final Report, it being understood that the U.S. Firm shall not make any changes or modifications that are inconsistent with these Terms of Reference.

The U.S. Firm shall prepare and deliver to the Grantee and USTDA a substantive and comprehensive final report of all work performed under these Terms of Reference (the "Final Report"), which must conform to the requirements under Clause I (Final Report) of the Mandatory Agreement of Understanding Clauses (as defined in Annex II). The U.S. Firm shall prepare the Final Report in English and Portuguese. The U.S. Firm shall organize the Final Report into chapters and sections with clear labels corresponding to each of the above tasks and sub-tasks of these Terms of Reference, and the U.S. Firm shall include in the Final Report all deliverables and documents that have been provided to the Grantee under these Terms of Reference. The U.S. Firm shall incorporate into the Final Report (i) all of the findings, recommendations and conclusions of the TA under these Terms of Reference, and (ii) all other documents and/or reports provided pursuant to the tasks noted above, in each case clearly organized and labeled according to each task and sub-task under these Terms of Reference. The U.S. Firm shall also include an executive summary to the Final Report as a whole, and provide a summary for each task under the Terms of Reference.

The U.S. Firm shall provide the Grantee with one (1) copy of the Final Report on CD-ROM. The CD-ROM version of the final report shall include:

- Adobe Acrobat readable copies of all documents;
- The summary power point presentation;
- Source files for all drawings in AutoCAD, Visio, or Bentley MicroStation format;
- Source files for any analytical tools used to complete the TOR;
- Source files for all documents in Microsoft Office 2000 or later formats.

ADDITIONAL COMMENTS

Comment 1: All Deliverables are to be supplied in both the English and Portuguese language versions. The US firm shall ensure the quality and accuracy of the translations.

Comment 2: More specific requirements concerning the composition of the consultant team are given in Section 12 of the Definitional Mission report.

Comment 3: Successful execution of the feasibility study presupposes that a) the U.S, Firm shall establish a close working relationship with ET; b) the team is prepared to spend the necessary amount of time on-site in-country; and c) the U.S. firm has appropriate access to ET officials and personnel, resources and data. Successful performance of the feasibility study is dependent on full and timely availability of the resources in question. It is expected that the prospective U.S. firms for carrying out the FS shall address these issues in their proposals, both in general terms and in terms of specific requirements (e.g., for desk space, phone, Internet connection).

XIV. SUGGESTED EVALUATION CRITERIA

It is suggested that the selection of the U.S. firm for both of the studies be based on the following criteria:

Criterion	**Max. Points**
• Expertise and skills of proposed personnel along with relevant technical experience of telecommunications networks, data centers, implementation of networks and datacenters • Experience supporting telecommunication roll-outs in the power sector; • Power and telecommunication sector project and regulatory experience in Latin America and specifically in Brazil; • Experience designing and implementing telecommunication projects in Brazil.	50
• Proposed approach to the TA and to the individual tasks. • Adequacy, soundness, and thoroughness of the Offeror's proposed Technical Approach and Work Plan.	30
• Pertinent international experience and cross-cultural skills along with relevant interdisciplinary experience of proposed personnel related to the Project.	20
Total:	**100**