ANALYSIS OF CREDIT DEMAND FOR INVESTMENT IN RENEWABLE PROJECTS IN NON-INTERCONNECTED ZONES AND/OR ISOLATED USERS IN COLOMBIA

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| **Acronyms and Abbreviations** |
| ALC | Latin America and the Caribbean |
| BANCOLDEX | Banco de desarrollo empresarial y comercio exterior de Colombia (Business Development and Foreign Commerce Bank of Colombia) |
| IDB | Inter-American Development Bank |
| CTF. | Clean Technology Fund  |
| CREG | Energy and Gas Regulation Commission  |
| COP | Colombian Pesos |
| ER | Renewable Energy |
| FAZNI | Financial support fund for energy service delivery in non-interconnected zones |
| MME | Ministry of Mines and Energy  |
| IFIs | Intermediary Financial Institutions (banking and non-banking) |
| IPSE | Institute for Planning and Promotion of Energy Solutions for ZNIs  |
| GDP  | Gross Domestic Product |
| PIEC | UPME Indicative Plan for Electricity Coverage Expansion 2013-2017 |
| UPME | Mining and Energy Planning Unit  |
| US$ SSPD | US DollarsSuperintendency of Domestic Public Services (). |
| SIN | Interconnected System  |
| ZNI | Non-Interconnected Zones  |

# Introduction.

This purpose of this document is to put the situation of energy service delivery in non-interconnected zones (ZNIs) into context and estimate the credit demand for renewable energy (ER) investment in these zones by technology operators and/or providers in Colombia, in order to help structure a Bancoldex line of credit with the support of the Clean Technology Fund (CTF). This is in accordance with Colombian government's progress in promoting investment in ER production and in contracting systems that have been developed in recent years and which could accelerate the participation of the private sector in this market.

Including specific objectives of:

* Establishing the market potential for investment in ER in ZNIs, taking into consideration the current regulatory framework and regulatory proposals for compensating production.
* Determining the investment required in terms of the number of projects that may be completed within a four-year timeframe with the technology available in the market and according to the selection of the target group of localities and operators.
* Calculating project benefits in terms of reducing operating costs and reducing emissions, taking into account the service life of the technologies considered for the program.
* Establishing the current operations and service delivery conditions
* Identifying the expectations for investment in renewable energy projects in the areas of operation
* Learning about sources for funding of the projects implemented and possible interest in using a bank funding source for their development
* Determining the interest of local financial institutions in financing this type of project and learning about their perception of risk associated with operations in ZNIs.

This document is composed of a quantitative estimate of the potential demand for credit, taking into consideration the installed capacities, energy consumption forecasts and the surveys and interviews conducted with operators in ZNIs, with technology providers and with local financial institutions.

The main purpose of the analysis is to estimate the market potential for investment in renewable technologies for electricity production in ZNIs and to determine the perception of market actors about entering this sector with private funds, taking into account the latest resolutions from the Ministry of Mines and Energy (MME)[[1]](#footnote-1) and the draft resolutions of the Energy and Gas Regulation Commission (CREG)[[2]](#footnote-2) on compensation for renewable production.

Primary information sources from the government and its agencies that manage and regulate the delivery of electricity services in ZNIs were used for the analysis, including the MME, Institute for Planning and Promotion of Energy Solutions for ZNIs (IPSE) [[3]](#footnote-3), the Mining and Energy Planning Unit (UPME) [[4]](#footnote-4), CREG and the Superintendent of Domestic Public Services (SSPD) [[5]](#footnote-5).

Specifically, IPSE's databases of installed capacities and production reports from operators to SSPD were taken into account, and they were complemented with information from sources such as UPME and information submitted by network operators according to an analysis of surveys and interviews that were conducted for this study. Additionally, meetings were held with government entities to verify their expectations with the program and to find out when the regulatory framework might be completed, which is related to compensation for renewable production and the incentives of Law 1715.[[6]](#footnote-6)  Meetings were also held with technology providers and local financial institutions in order to understand their interest and expectations from this market.

In order to create the production forecasts for upcoming years, a group of localities was selected based on two criteria: installed power of more than 500 kW and having telemetry from the National Monitoring Center[[7]](#footnote-7)  operated by IPSE. In this way, a general pool of 43 localities and 37 operators was obtained from the target group of localities and operators.

A group of four technologies was selected (hybrid – solar systems, solar photovoltaic systems, small hydroelectric plants (PCH) and biomass for electricity production) as the most likely to be installed, considering their availability in the country, the potential for renewable resources in the ZNIs, the existence of providers with experience to develop the projects, and interest on the part of operators. Investment and operating costs were established for these technologies, and the potential for investment in the 4-year timeframe of a funding program was ascertained. Additionally, the savings in operating costs and emissions reduction were calculated for a 25-year timeframe, which is considered to be the service life of the proposed technologies.

The results of the study predict the potential for investment in renewable energy in ZNIs according to the increase in the power installed, the government’s goals in its PROURE plan[[8]](#footnote-8)  and the expectations of the different actors that were consulted.

# CHARACTERIZATION OF THE PROGRAM

# Pool of Users and Operators in Non-interconnected Zones (ZNIs)

According to the information available from IPSE, the ZNI market is composed of 1,118 localities that are in ZNIs, and in which 1,414 motors are installed with a total power of 261.6 MWe. Of this power, 9.1 MWe are renewable, therefore the current portion of renewable energy is barely 3.5%. According to the PROURE plan, the ER penetration goal in ZNIs is 30% of installed power by the year 2020.

The greatest installed capacity is in San Andrés and Amazonas, localities that currently have an Exclusive Service Area (ASE) scheme, and in the departments of Chocó and Putumayo.

According to the information from CREG, a total of 94 operators provide service in ZNIs. The entire list of providers registered by CREG is provided in Appendix 1. According to the information recorded in the database of the Superintendent of Domestic Public Services from 65 operators that submitted reports in 2014, the total number of users in ZNIs stands at 180,338, the distribution of which is presented in Figure 1.

As shown in Figure 1, of the total number of registered users in 2014, 80% correspond to level 1 and 9% to level 2; and all other users correspond to levels 3, 4, 5 and 6 and commercial, industrial and official users.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Department** | **No. of Communities** | **No. of Motors** | **Motor Installed Power (kW)** | **Renewable Installed Power (kW)** | **Total Power (kW)** | **Participation** |
| Amazonas | 46 | 69 |  34,569  |  -  |  34,569  | 13% |
| Antioquia | 38 | 46 |  3,036  |  -  |  3,036  | 1% |
| San Andrés and Providencia | 2 | 22 |  61,874  |  -  |  61,874  | 24% |
| Bolivar | 1 | 3 |  520  |  25  |  545  | 0% |
| Caqueta | 45 | 67 |  10,497  |  -  |  10,497  | 4% |
| Casanare | 11 | 12 |  2,618  |  -  |  2,618  | 1% |
| Cauca | 98 | 116 |  12,375  |  -  |  12,375  | 5% |
| Chocó | 210 | 265 |  31,506  |  8,813  |  40,319  | 15% |
| Guainia | 61 | 67 |  7,482  |  -  |  7,482  | 3% |
| Guaviare | 46 | 46 |  5,066  |  1  |  5,067  | 2% |
| La Guajira | 3 | 5 |  562  |  200  |  762  | 0% |
| Meta | 38 | 62 |  9,091  |  -  |  9,091  | 3% |
| Nariño | 405 | 459 |  33,362  |  48  |  33,410  | 13% |
| Putumayo | 46 | 64 |  14,263  |  -  |  14,263  | 5% |
| Valle del Cauca | 1 | 1 |  75  |  -  |  75  | 0% |
| Vaupes | 41 | 55 |  7,966  |  8  |  7,974  | 3% |
| Vichada | 26 | 55 |  17,650  |  -  |  17,650  | 7% |
| Total | 1118 | 1414 |  252,510  |  9,094  |  261,605  | 100% |



|  |  |
| --- | --- |
| Estrato | Level |
| Comerciales | Comercial |
| Industriales | Industrial |
| Institucionales | Institutional |

Figure 1 Distribution of users by ZNI type, 2014. (Source: Compiled from the SSPD database).

This distribution makes the provision of service in the ZNIs highly subsidized by the state, which pays the difference between the expenses for the provision of service and the rate that corresponds to the user, according to their economic level and activity.

|  |  |
| --- | --- |
| >10.000 | >10,000 |
| Entre 5.000 y 10.000 | Between 5,000 and 10,000 |
| Entre 1.000 y 5.000 | Between 1,000 and 5,000 |
| Entre 0 y 1.000 | Between 0 and 1,000 |

Figure 2 User distribution by operator. (Source: Compiled from the SSPD database).

Very few operators have more than 10,000 users, and less than 10% have between 5,000 and 10,000 users. The majority of operators (35.5%) have between 1,000 and 5,000 users.

Figure 3 shows the distribution of installed power by locality.

Figure 3 Power distribution by community. (Source: Compiled from the IPSE database).

|  |  |
| --- | --- |
| Comunidades menos de 100 KW | Communities wth less than 100 KW |
| Entre 1.000 y 2.000 KW | Between 1,000 and 2,000 kw |
| Entre 5.000 y 10.000 KW | Between 5,000 and 10,000 kw |
| Más de 20.000 KW | More than 20,000 KW |
| Entre 100 y 1.000 kW | Between 100 and 1,000 kw |
| Entre 2.000 y 5.000 KW | Between 2,000 and 5,000 kw |
| Entre 10.000 y 20.000 KW | Between 10,000 and 20,000 kw |

The majority of communities (86%) have less than 100 kW of installed power and 11% have between 100 and 1,000 kW installed.

# Target Population

Taking into account the aforementioned distribution, in order to select the target population the following criteria have been established:

* Installed Power. Populations with more than 500 kW installed. Of the 1,118 communities to which service is provided in the ZNIs, only 52 have a capacity greater than 500 kW.
* Populations with energy production monitoring. Populations that have electricity production monitoring through the National Monitoring Center by means of IPSE, and which allow consumption forecasts to be made. Of the 52 aforementioned populations, only 43 have energy monitoring.

Under these conditions, Table 2 shows the populations that comply with these criteria.

Table 2. Target localities. (Source: Compiled from IPSE information).

| **No.** | **Population** | **Locality** | **Power (kW)** | **Energy Generated (kWh/year)** | **Hours of Operation (2013)** |
| --- | --- | --- | --- | --- | --- |
| 1 | SIPI | SIPI | 580 | 65,932 | 3 |
| 2 | BOJAYA (BELLAVISTA) | BELLAVISTA | 1,180 | 419,739 | 6 |
| 3 | MEDIO ATRATO (BETE) | BETE | 590 | 43,088 | 2 |
| 4 | LA TOLA | LA TOLA | 2,330 | 1,097,318 | 12 |
| 5 | ACANDI | CAPURGANA | 2,000 | 2,431,276 | 15 |
| 6 | EL CHARCO | BAZAN | 516 | 105,996 | 4 |
| 7 | CARURU | CARURU | 515 | 243.187 | 7 |
| 8 | TUMACO | CHAJAL | 500 | 224.635 | 4 |
| 9 | CUMARIBO | CUMARIBO | 3,177 | 1,343,372 | 6 |
| 10 | JURADO | JURADO | 1,514 | 747,674 | 9 |
| 11 | ACANDI | ACANDI | 4,572 | 4,233,324 | 16 |
| 12 | EL CHARCO | SAN JOSE | 518 | 160,510 | 5 |
| 13 | SANTA BARBARA (ISCUANDE) | ISCUANDE | 1,174 | 1,268,868 | 12 |
| 14 | CARTAGENA | ISLA FUERTE | 545 | 285,623 | 10 |
| 15 | LOPEZ (MICAY) | MICAY | 1,641 | 1,556,957 | 14 |
| 16 | BAJO BAUDO (PIZARRO) | PIZARRO | 1,950 | 1,625,659 | 12 |
| 17 | SANTA ROSALIA | SANTA ROSALIA | 1,337 | 1,594,553 | 16 |
| 18 | MIRAFLORES | MIRAFLORES | 824 | 619,082 | 9 |
| 19 | LA PRIMAVERA | LA PRIMAVERA | 2,848 | 3,710,314 | 15 |
| 20 | UNGUIA | UNGUIA | 1,320 | 1,398,981 | 10 |
| 21 | LETICIA | LETICIA | 20,443 | 52,905,358 | 24 |
| 22 | BAHIA SOLANO (MUTIS) | MUTIS | 2,780 | 7,240,887 | 23 |
| 23 | MAPIRIPAN | MAPIRIPAN | 500 | 1,403,371 | 24 |
| 24 | MITU | MITU | 3,750 | 11,370,567 | 23 |
| 25 | MOSQUERA | MOSQUERA | 900 | 789,731 | 8 |
| 26 | FRANCISCO PIZARRO | SALAHONDA | 1,700 | 2,764,561 | 12 |
| 27 | URIBIA | NAZARETH | 934 | 154,648 | 5 |
| 28 | INIRIDA | INIRIDA | 5,265 | 17.974.229 | 24 |
| 29 | NUQUI | NUQUI | 600 | 982,816 | 11 |
| 30 | PUERTO LEGUIZAMO | LEGUIZAMO | 4,500 | 16,290,696 | 24 |
| 31 | BUENAVENTURA | PUERTO MERIZALDE | 500 | 35,033 | 1 |
| 32 | PUERTO LEGUIZAMO | PUERTO OSPINA | 724 | 109,243 | 7 |
| 33 | CARTAGENA DEL CHAIRA | REMOLINO DEL CAGUAN | 700 | 205.348 | 7 |
| 34 | TIMBIQUI | TIMBIQUI | 1,207 | 4,626,123 | 24 |
| 35 | SAN ANDRES | SAN ANDRES | 64,999 | 256,618,047 | 24 |
| 36 | MILAN | SAN ANTONIO DE GETUC | 580 | 64,199 | 5 |
| 37 | GUAPI | GUAPI | 3,300 | 13,156,676 | 24 |
| 38 | EL CHARCO | EL CHARCO | 1,900 | 3,968,893 | 12 |
| 39 | OLAYA HERRERA | BOCAS DE SATINGA | 2,300 | 8,288,548 | 20 |
| 40 | SOLANO | SOLANO | 765 | 579,543 | 6 |
| 41 | PUERTO CARREÑO | CARREÑO | 5,750 | 25,805,990 | 24 |
| 42 | PROVIDENCIA | PROVIDENCIA | 3,737 | 14,848,958 | 20 |
| 43 | VIGIA DEL FUERTE | VIGIA DEL FUERTE | 560 | 1,057,316 | 8 |

The 43 selected communities have 158 MWe of installed power, equivalent to 60% of the total installed power in the ZNIs. The energy produced in these localities in 2013 reached 464 GWh, which surpassed the energy invoiced in 2013 since the reactive energy values, and those lost in distribution, are included in the production records.

In the communities selected for the sample, an average production of 13 hours per day in 2013 was reported by IPSE, according to the measurements made by the National Monitoring Center[[9]](#footnote-9).

Table 3 shows the number of operators that provide service in these communities. In total, in the 43 selected communities, 37 operators provide energy service. The number of users serviced by these companies is 128,078, which is equivalent to 71% of the users with service in the ZNIs. The above permits the conclusion that 39% of the operators have 71% of the users, with which they have a greater possibility and potential to develop renewable energy projects in the ZNIs.

Table 3. Number of operators in the target group.

| No | **OPERATOR** | **TOTAL USERS SERVICED BY THE OPERATOR** |
| --- | --- | --- |
| 1 | MUNICIPIO DE SIPI | 1351 |
| 2 | COMPAÑÍA DE SERVICIOS PÚBLICOS DOMICILIARIOS DE BOJAYA S.A. E.S.P. | 2270 |
| 3 | MUNICIPIO DEL MEDIO ATRATO  | 1238 |
| 4 | EMPRESA ASOCIATIVA DE TRABAJO PARA LA PRESTACIÓN DEL SERVICIO DE ENERGÍA ELÉCTRICA EN LA PARTE BAJA DE LA TOLA | 1654 |
| 5 | JUNTA ADMINISTRADORA DE SERVICIOS PÚBLICOS DE CAPURGANA | 1270 |
| 6 | ASOCIACIÓN DE ENERGÍA DE LAS ZONAS RURALES DEL MUNICIPIO DE EL CHARCO | 4793 |
| 7 | MUNICIPALITY OF CARURU, VAUPES | 164 |
| 8 | E.A.T. DE PRESTACIÓN DE SERVICIOS PÚBLICOS DE LA LOCALIDAD DEL CHAJAL MUNICIPIO DE TUMACO | 1071 |
| 9 | EMPRESA DE ENERGÍA DEL GUAINIA LA CEIBA S.A. E.S.P. | 6461 |
| 10 | ELECTRIFICADORA DEL PACIFICO S.A. E.S.P. | 1341 |
| 11 | EMPRESA DE SERVICIOS PÚBLICOS DE ACANDI S.A. E.S.P. | 2874 |
| 12 | ASOCIACIÓN DE USUARIOS DEL SERVICIO DE ENERGÍA ELÉCTRICA DE LA ZONA RURAL DE SANTA BARBARA DE ISCUANDE  | 4860 |
| 13 | COOPERATIVA COMUNITARIA DE SERVICIOS PÚBLICOS DE ISLA FUERTE | 336 |
| 14 | COOPERATIVA DE SERVICIOS PÚBLICOS DE LÓPEZ DE MICAY | 3725 |
| 15 | E. S. P. DE ENERGÍA ELÉCTRICA DE BAJO BAUDO PIZARRO S.A. | 5210 |
| 16 | EMPRESA DE ENERGÍA ELÉCTRICA DEL DEPARTAMENTO DEL VICHADA S.A. | 6155 |
| 17 | MUNICIPIO DE MIRAFLORES GUAVIARE | 776 |
| 18 | EMPRESA DE GAS Y ENERGÍA ELÉCTRICA SIGLO XXI | 1591 |
| 19 | EMPRESA DE SERVICIOS PÚBLICOS DOMICILIARIOS DE UNGUIA S.A. E.S.P. | 2456 |
| 20 | ENERGÍA PARA EL AMAZONAS S.A. E.S.P. | 9485 |
| 21 | EMPRESA DE SERVICIOS PÚBLICOS DE BAHIA SOLANO S.A. E.S.P. | 2433 |
| 22 | ELECTRIFICADORA DE MAPIRIPÁN S.A. E.S.P. | 469 |
| 23 | DEPARTMENT OF VAUPES | 2203 |
| 24 | E.A.T. DE PRESTACIÓN DE SERVICIOS PÚBLICOS DEL MUNICIPIO DE MOSQUERA EL PORVENIR E.S.P. | 2835 |
| 25 | EMPRESA DE ENERGÍA DE SALAHONDA S.A. E.S.P. | 2200 |
| 26 | EMPRESA ELECTRIFICADORA DE NUQUI E.S.P. S. A. MIXED ECONOMY | 2420 |
| 27 | EMPRESA DE SERVICIOS PÚBLICOS DE LEGUIZAMO | 3804 |
| 28 | ASOCIACIÓN DE USUARIOS DEL SERVICIO DE ENERGÍA ELÉCTRICA DE PUERTO MERIZALDE | 423 |
| 29 | EMPRESA DE SERVICIOS PÚBLICOS DE LEGUIZAMO | 3804 |
| 30 | GENDECAR S.A. E.S.P. | 6548 |
| 31 | EMPRESA DE SERVICIOS PÚBLICOS DEL OCCIDENTE COLOMBIANO S.A. | 3542 |
| 32 | SOCIEDAD PRODUCTORA DE ENERGÍA DE SAN ANDRES Y PROVIDENCIA S.A. E.S.P. | 19182 |
| 33 | EMPRESA DE SERVICIOS PÚBLICOS DE SAN ANTONIO DE GETUCHA S.A. E.S.P. | 208 |
| 34 | EMPRESA MIXTA DE SERVICIOS PÚBLICOS DE ENERGÍA ELÉCTRICA DE GUAPI ENERGUAPI S.A. E.S.P. | 6890 |
| 35 | EMPRESA ASOCIATIVA DE TRABAJO ENERGÍA DEL SUR | 3245 |
| 36 | EMPRESA ASOCIATIVA DE TRABAJO ENERGÍA DE OLAYA HERRERA EAT ENEROLAYAHERRERA E.S.P. | 3938 |
| 37 | EMPRESA MUNICIPAL DE SERVICIOS PÚBLICOS DOMICILIARIOS DE VIGIA DEL FUERTE | 4853 |

# Diesel Consumption and Current Emissions.

According to IPSE, the measured efficiency of the production plants in the localities with greater installed power is 31%[[10]](#footnote-10), therefore the consumption of [missing text] in order to produce one kWh is 0.0825 gallons. The emission factor of [missing text] according to the FECOC of the UPME is 10.16 Kg of CO2 per gallon, therefore the emission factor for electricity production in ZNI is 0.83 Kg CO2/kWh.

Thus, according to the energy production information reported by IPSE in the 43 communities that have telemetry, consumption in 2013 was 36.97 million gallons and the emissions were 375,650 tons of CO2.

# Energy Production Forecasts and New Power Required

In order to forecast the energy produced in upcoming years for the target group in the ZNI populations, the following criteria were taken into account:

* Energy consumption in the ZNIs that had energy service increased similarly to the national GDP, although this projection is not exact given that the GDP and its forecasts for the target communities are not known. It is an internationally accepted trend that energy consumption increases proportionally equal to or greater than the growth of the economy. Information published by Bancolombia and Banco de la República was used for the projections.[[11]](#footnote-11)
* The hours of operation for provision of service in the communities that still do not have 24 hours of service are expected to increase 0.5h/year over the next 15 years, and then to increase 1 hour per year, in a conservative scenario. The increase in hours of operation depends on the budgets allocated by the government through the MME and IPSE plans that ended in 2014, and on those for which new plans have not been published.
* The entry of new users who do not currently have electricity service is not considered. According to the PIEC of the UPME there are currently 55,809 users in the ZNIs that do not have service and that are not inter-connectable to the SIN. In order to provide service to these users, the UPME calculates that investments of US$161.987 million are needed.

The following figure shows the projection of energy consumption in the communities established as the target group according to the aforementioned assumptions.

Figure 4 Projection of energy production in the group of target communities. (Source: Compiled by author)

|  |  |
| --- | --- |
| Energía Generada (KWh/año) | Energy Generated (KWh/year) |

The energy production in 2013 was 464 GWh, according to the information reported by IPSE. Based on this value, and taking into account the criteria, in order to reach the projection, the energy produced in these communities in 2040 would have to be greater than 1,400 GWh/year. This represents a 3-fold increase with respect to generation in 2013. It is important to clarify that the energy produced does not correspond to the energy invoiced by the operators, since reactive energy and the losses in the distribution networks are not invoiced. Also, not all users have micro-measurement devices (energy meters).

Based on the energy generation forecast, the new power that must be installed to supply said generation is calculated. The figure that follows shows the projected growth of installed capacity. As one can see, it is projected that by 2040 the installed power will be approximately 270 MWe in the communities selected for study.

Figure 5 Projection of the new power required in the target group of communities. (Source: Compiled by author)

|  |  |
| --- | --- |
| Potencia (KW) | Power (KW) |

It is important to note that the current installed power is 158 MWe and the average power used in accordance with the energy generated in 2013 and the average hours of operation per day was 100 MW, with which the average plant factor was 63%. For the projection of the new power, the fact that the plant factor remains constant while the hours of operation increase was taken into consideration.

# New Required Renewable Electric Power

As explained above, the portion of renewable power installed today in the ZNI is just 3.5%, according to the information provided by the IPSE; the government's goals, through the PROURE plan, are to achieve 30% of installed power in renewables in the ZNIs by 2020; to achieve this goal in 2040, it is necessary that of the new power required in the ZNI in the target group of communities selected for the market study 70% be renewable and 30% be potential with engines.

In accordance with this projection, the following figure shows the projections of renewable power that should be installed each year, the accumulated power and the renewable fraction in accordance with the total installed power.

Figure 6 New required renewable power and renewable portion. (Source: Compiled by author)

|  |  |
| --- | --- |
| Potencia (KW) | Power (KW) |
| Nueva Potencia Renovable (KW) | New Renewable Energy (KW) |
| Potencia Nueva Renovable Acumulada (KW) | New Accumulated Renewable Energy (KW) |
| Fracción Renovable | Renewable Portion |

As one can see in Figure 6, the new power required in 2040 is approximately 80 MWe, and the renewable fraction in said scenario for the group of communities selected for analysis achieves the goal of 30% envisaged by the Government in the PROURE plan for 2020.

# Renewable Technologies Considered and Required Investments

Taking the locations of the ZNIs (see Figure 7) and their access characteristics into consideration, the following are considered priority technologies for the analysis of this study: (i) Solar photovoltaic hybrid systems, (ii) Solar photovoltaic systems, (iii) Small Hydroelectric plants (SHPs), and (iv) Biomass for electricity production.



Figure 7. Location of the ZNIs. Source: Proposal for remuneration for the generation, distribution, and marketing of Electricity in the ZNIs. CREG (2014) Bogota.

Which are described briefly below:

* Solar photovoltaic hybrid system.

A generation system that includes conventional and unconventional sources can be called "hybrid." In the case of this study, the system comprised of unconventional energy sources, including conventional energy sources, is considered "hybrid."

In Colombia, solar photovoltaic generation is becoming increasingly common as a solution for homes that are isolated from the electricity system. These systems are normally low power and have batteries for energy storage. For facilities in the ZNIs, the design of hybrid facilities that operate simultaneously with the existing electricity generation systems, but without storage systems that make the facility more expensive, is proposed. This alternative seeks an intermediate point that makes the operation of a joint generation system, which uses the potential energy resources and has support such as that which is already available in the ZNI (e.g., diesel), viable. It is estimated that in these types of facilities the photovoltaic system can produce between 30% and 40% of the total energy currently produced with the diesel engines. Also reducing charges such as the cost of fuel, since under this system it is proposed that the diesel plants provide support for peak consumption; these types of generators become a reserve for the system, being used only when demand is high, for a few hours and every two or three weeks. Also, there are reduced costs of operation, maintenance, and contaminating emissions from the machine.

Currently, according to information published by IPSE, nine projects are being developed in the ZNIs using solar photovoltaic systems. Five of these projects are hybrid, with existing diesel generation plants. Logistics for the installation, fuel supply, operation, maintenance, and response time for repair of breakdowns are mentioend as issues for consideration.

These systems are of particular interest because they do not use non-renewable natural resources and their environmental impact is very low.

The UPME published a map of the solar resources[[12]](#footnote-12)  in Colombia, which permits the design of facilities with a certain level of reliability.

Consideration is being given to adding solar photovoltaic systems operating jointly for the current generation systems, with a maximum [market] penetration of 30%, which do not require batteries for their proper operation.

* Solar photovoltaic systems. When comparing the solar radiation map [[13]](#footnote-13)  (multi-year average solar radiation for the entire country) and the map of the ZNI in Colombia (see Figure 7), one can identify the regions of the ZNI where there is the most potential for this technology. These include Guajira, San Andres, Amazonia, Orinoquia, and the Pacific coastal region. Where, analyzing the radiation figures, one finds that the country has good solar energy potential throughout the territory, with a daily average of 4.5 kWh/m2, suitable for appropriate use of this energy resource, with the enormous advantage that the solar radiation is uniform throughout the year.

In short, Colombia is a country with good levels of radiation so that in most of the regions this technology can operate efficiently, with good results. Several system operators who were surveyed in this market study consider [sic] the most viable solution for electrifying their communities, given the feasibility of individual solutions.

* Small Hydroelectric Plants (SHP). The country has ample hydric resources in the ZNI and ample hydroelectric potential[[14]](#footnote-14); various studies estimate it to be 90 GW (without considering environmental and social restrictions), of which 10% (9 GW) has been developed. The IPSE is encouraging the development of these types of projects, given their low operating and maintenance costs and their long service life; also, the country has engineering companies with broad experience in these types of projects on a small and medium scale. Currently, the SHPs are among the most competitive options for renewable generation.
* Biomass for electricity production. Because of the conditions in the ZNIs, the availability of biomass is high; waste materials such as bagasse, palm seed, rice husk, and forest waste material can be used as energy sources for generation, employing technologies for combustion or gasification of biomass. These types of projects require assurance of the supply of biomass over the long term, and the costs of transport must be evaluated; normally the resource should not be more than 50 Km away so that generation will be profitable. Colombia has ample experience in using biomass resources for electricity generation, especially in the sugar and palm sectors, where the biomass potential [[15]](#footnote-15) is found in various Departments, which coincide [with] and are superimposed on several ZNI areas of interest. Also, in recent years, some companies have started engaging in the use of the biogas produced in agroindustrial sewage treatment plants for electricity generation. Therefore, we believe that biomass technology will play an important role in the energy future of the ZNI, with much greater positive social impact than the solar or hydroelectric projects.

Wind energy is not considered potential technology in the market study, given that the few studies that have been conducted in the country have shown that the greatest potential for this resource is located on the Guajira peninsula, and in this area there are just two communities with electricity service, according to the information provided by the IPSE. However, this does not exclude it as a renewable technology suitable for the ZNI and of investment interest to the private sector.

# Technology Investment, Operation and Maintenance Costs

To establish the CAPEX and OPEX costs of the various technologies, an analysis of various sources to determine the average amounts with which the analysis of investment and savings was conducted. The results are shown in the following table.

Table 4. Average CAPEX and OPEX costs per technology. Source: Estimates developed by the IDB based on average expenses in UPME, IPSE, and projects existing in ZNI.

|  |  |  |
| --- | --- | --- |
| **Technology** | **CAPEX (US$/kW)** | **OPEX (US$/kWh)** |
| Diesel\* | 530 | 0.22 |
| Diesel + Photovoltaic Hybrid | 3,291 | 0.20 |
| Photovoltaic | 3,192 | 0.024 |
| SHPs | 3,448 | 0.021 |
| Biomass | 2,906 | 0.068 |

\* The CAPEX costs of Diesel are currently covered with support from the Government, and the OPEX under the tariff and subsidy system.

To confirm the above amounts we looked for data on investment costs of projects that are being planned or have been carried out by the IPSE in the ZNI. Tables 5 AND 6 summarize the results.

Table 5. Solar - diesel hybrid projects that the IPSE plans to install. (Source: [IPSE General analysis of Law 1715 and its impact on the ZNIs in Colombia](http://www1.upme.gov.co/sgic/?q=content/taller-generaci%C3%B3n-con-fncer-en-zni-presentaci%C3%B3n-%E2%80%98an%C3%A1lisis-general-de-la-ley-1715-y-su))

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Department** | **Locality** | **Capacity to be installed (kW)** | **Investment Value (Million COP$)** | **Specific Investment (US$/kW)** |
| Vichada | Cumaribo | 1600 | 7500 |  1,563  |
| Vaupés | Taraira | 400 | 1800 |  1,500  |
| Vaupés | Caruru | 400 | 1800 |  1,500  |
| Vichada | Casuarito | 250 | 1800 |  2,400  |
| Guainía | San Felipe | 120 | 1200 |  3,333  |
| Average |  |  2,059 |

Table 6. Hydroelectric projects that IPSE has implemented or plans to install. (Source: [IPSE General analysis of Law 1715 and its impact on the ZNIs in Colombia](http://www1.upme.gov.co/sgic/?q=content/taller-generaci%C3%B3n-con-fncer-en-zni-presentaci%C3%B3n-%E2%80%98an%C3%A1lisis-general-de-la-ley-1715-y-su))

|  |  |  |  |
| --- | --- | --- | --- |
| **Locality** | **Power (kW)** | **Investment Value (Million COP$)** | **Specific Investment (US$/kW)** |
| Arusi | 100 | 2,000 |  6,667  |
| Guacamayas | 125 | 1,790 |  4,773  |
| Bahía Solano | 1875 | 18,000 |  3,200  |
| Cúpica | 300 | 2,500 |  2,778  |
| López de Micay | 300 | 2,100 |  2,333  |
| Average |  |  3,950 |

As one can see, the average amounts are on the order of the prices established as average for the investment analysis.

# [Market] Penetration of the Renewable Technologies

For the market analysis, the [market] penetration of renewable energies was considered in the following proportion[s].

* Hybrid 30%
* Solar 30 %
* SHP 20 %
* Biomass 20%

This scenario is considered feasible, bearing in mind the fact that, according to the surveys and meetings conducted with operators in various zones, several of them are considering developing these types of projects based on approximately these proportions.

# Projection of Projects and Investments

Bearing in mind the requirements for power in the target localities, Figure 8 shows the projection of investments and the number of projects that should be carried out each year in order to meet the government's goals in its PROURE plan, bearing in mind that the average installed power in the target localities is 3.67 MWe.



Figure 8 Projection of investments and projects in ZNI. (Source: Compiled by author)

|  |  |
| --- | --- |
| Número de Proyectos | Number or Projects |
| Inversiones Acumuladas (US$) | Accumulated Investments (US$) |
| Número de Proyectos | Number or Projects |
| Cumulative Investments | Cumulative Investments |

In total, up until 2040 investments of 243 million dollars are required in order to achieve the goal of 30% renewable power.

Bearing the life of the intended investment program in mind, the following table summarizes the principal investment figures for the coming 4 years, considering the [market] penetration of the technologies being considered and the investment costs.

According to table 7, in the first four years in which the financing program would be operating 8.8 MWe must be installed, which requires an investment of 28.3 million dollars. It is envisaged that the program will contribute US$ 19.265 million, and it is assumed that these resources can leverage financing of local financial institutions and additional investment[s] in *equity*  at a factor of 0.3.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Distribution by type of project. | No. Projects | Total Power (MW) | Average Power per Project (MWe) | Investment in Technology (US$) | CTF Investment Resources (US$) | Investment from Other Sources (US$) |
| Hybrid | 4 |  2,638  | 659.5 |  $8,681,446  |  $6,140,307  |  $2,541,139  |
| Solar  | 4 |  2,638  | 659.5 |  $8,421,170  |  $5,956,216  |  $2,464,954  |
| SHP | 2 |  1,759  | 879.3 |  $6,063,735  |  $4,288,824  |  $1,774,911  |
| Biomass | 2 |  1,759  | 879.3 |  $5,110,561  |  $3,614,653  |  $1,495,908  |
| Total | 12 |  8,793  | 732.8  |  $28,276,912  |  $20,000,000  |  $8,276,912  |

Table 7. Distribution by project and financing financing horizon.

If this investment is made in diesel technology only, the estimated amounts are US$ 6.6 Billion (530 US$/kW installed).

# Projection of generation with the power installed in the project.

Figure 8 shows the production projections for the projects that would be financed.

Figure 9 Projection of generation with the power installed in the project. (Source: Compiled by author)

|  |  |
| --- | --- |
| Energía Generada (KWh) | Energy Generated (KWh) |

Starting with year 4, energy production increases because of the increase in hours of service provision that was taken into consideration in the analysis. More power is not installed, but the installed power increases its hours of operation.

# Surveys of Operators, Technology Providers, and Local Financial Institutions

As part of the market study and [a] tool for corroboration of data based on the limitations of available information, operators and technology providers were surveyed and interviewed and interviews were held with Local Financial Institutions, with the following objectives:

* Establish the current operation and service provision conditions
* Understand the expectations for investment in renewable energy projects in the zones where they operate.
* Understand the sources of financing of the projects they implement and their potential interest in using a bank source of financing for their implementation.
* Determine the Local Financial Institutions' interest in financing these types of projects and find out their perception of the risk with respect to the operations in the ZNI.

Two model surveys were developed for this activity, one for operators and another for technology providers. Appendix 1 contains the database of operators; appendix 2 contains the database of technology providers, and appendix 3 contains the 3 survey forms that were developed.

From the pool of operators (94 according to the CREG database), 14 surveys of operators were received, 6 interviews were conducted, and one group session was held. For the 15 technology providers identified, 9 surveys were carried out, 3 interviews were conducted, and one group session was held.

# Results of Operator Surveys

Following are the principle results of the surveys and the analysis thereof.

Initially, we sought to determine the legal nature of the operators in order to confirm that they are eligible to take out loans in order to carry out their activities and projects. The survey confirmed that most of the operators (86%) are mixed or private and that their contracting system is private, and consequently they can have access to loans with commercial banks and they can have access to the resources of the line [of credit] being structured by Bancoldex.

Figure 10 Legal nature of the operators. (Source: Compiled by author)

|  |  |
| --- | --- |
| MIXTA | MIXED |
| PRIVADA | PRIVATE |
| PUBLICA | PUBLIC |
| NO RESPONDE | NO RESPONSE |

Figure 11 presents the results of the question concerning which of the activities the operator participates in, confirming that 71% of the surveyed operators participate in the three activities of energy production, distribution, and marketing and 14% participate only in the generation activity.

Figure 11 Participation in the ZNI activities. (Source: Compiled by author)

|  |  |
| --- | --- |
| GEN. DISTR. COMERC. | GEN. DISTR. SALE |
| SOLO GENERACION | ONLY GENERATION |
| DISTRIB. COMERC. | DISTRIB. SALE |
| SOLO COMERC. | ONLY SUPPLY |

Figure 12 shows the distribution of installed capacity by operator. The greatest generating capacity is operated by the companies that have the San Andrés and Amazonas concessions, followed by specialized operators such as Gensa[[16]](#footnote-16)  and Centrales Eléctricas de Nariño SAESP (Cedenar)[[17]](#footnote-17) and the regional electrifiers that provide the service in their areas of operation.

As Figure 13 shows, 89% of the installed capacity in the localities of the surveyed operators corresponds to diesel engines, 10% to small hydroelectric plants, and 0.14% to solar photovoltaic facilities. This distribution confirms the technologies that were considered to determine the projects’ savings potentials.

Figure 14 shows the responses from operators related to the production systems' operating conditions, 71% find that it is in good condition and 7% consider it to be in fair condition. 21% of operators did not answer this question.

Figure 12 Capacity installed by operator. (Source: Compiled by author)

Figure 13 Distribution of the installed capacity by technology type. (Source: Compiled by author)

|  |  |
| --- | --- |
| DIESEL  | DIESEL  |
| HIDROELECTRICA | HYDROELECTRIC |
| SOLAR | SOLAR |

Figure 14 Conditions of the production systems. (Source: Compiled by author)

|  |  |
| --- | --- |
| BUENO  | GOOD  |
| REGULAR | FAIR |
| NO RESPONDE | NO RESPONSE |

Figure 15 shows the results of the question on distribution systems losses, most companies that answered the survey report losses of 10% and two of them report 20% losses.

Figure 15 Energy loss during distribution. (Source: Compiled by author)

Figure 16 shows the results of the question regarding increasing capacity and its intention to invest in renewable energy projects. 79% of the surveyed companies say that they plan to expand the installed power. In addition, of all operators who wish to increase their installed capacity, 45% have planned to do it with renewable energy sources, 34% plan to build new generation capacities with conventional energy sources and only 11% are indifferent to the type of energy solution because of being clearly marketers or distributors. The most popular renewable energy source between the ones surveys is the hybrid photovoltaeic.

Figure 16 Intention to increase installed capacity with renewable sources. (Source: Compiled by author)

|  |  |
| --- | --- |
| NO | NO |
| RENOVABLE | RENEWABLE |
| DIESEL | DIESEL |
| HIBRIDO | HYBRID |
| INDIFERENTE | NO OPINION |

Among the reported renewable energy investment projects is a solar park for Amazonas, a solar park for Inirida and a PCH in Juradó. This analysis does not consider the San Andrés wind power project, since it is in the process of consultation with the community and land use plans.

Figure 17 shows the answers from operators regarding financing sources, 55% think that their financing source is state funds (FAZNI and FAER) and 45% consider obtaining resources from other sources to finance the service expansion projects. Regarding the question of whether they they have considered third party participation in the expansion of production capacity, 45% have not considered it, 36% have assessed the possibility and 18% do not know.

Although third party investment seemed new, many surveyed operators answered favorably with regard to this possibility, which confirms that in addition to considering investment in renewable energy, they also consider alternative financing sources to develop their projects.

Figure 17 Main financing sources. (Source: Compiled by author)

|  |  |
| --- | --- |
| PRESTAMO | LOAN |
| FONDOS DEL ESTADO | STATE FUNDS |

Figure 18 Financing with third party investments. (Source: Compiled by author)

|  |  |
| --- | --- |
| NO | NO |
| SI | YES |
| NO SABE/ NO RESPONDE | DOESN'T KNOW/NO RESPONSE |

Figure 19 Barriers to investment in ER (renewable energy). (Source: Compiled by author)

|  |  |
| --- | --- |
| FALTA DE RECURSOS FINANCIEROS | LACK OF FINANCIAL RESOURCES |
| FALTA DE APOYO DEL IPSE | LACK OF IPSE SUPPORT |
| DIFICULTAD DE ACCESO A PRESTAMO | DIFFICULTY ACCESSING LOANS |
| NR | NO RESPONSE |
| FALTA DE REGULACION EN EL SECTOR | LACK OF REGULATION IN THE SECTOR |
| DIFICULTAD DE ACCESO A LA ZONA | DIFFICULTY ACCESSING THE ZONE |
| NA | NA |

Finally, on the question of the main barrier to investing in renewable energy projects (Figure 19), 21% of those surveyed consider it to be the lack of financial resources, 14% think it is a lack of regulation of the sector, 14% think it is a lack of support from IPSE and 21% did not answer the question.

# Results of Operator Interviews.

The purpose of the interviews was to obtain feedback from the operators for the ZNI (non-interconnected zones) energizing model replacing power generation through fossil fuels with generation with renewable sources and to complement and verify the results analyzed using surveys and government databases. In addition, these visits and interviews allowed greater and more intimate knowledge of the barriers that hinder ZNI operators in the development of new projects.

Operators visited were:

* GENSA E.S.P[[18]](#footnote-18). , operator of the power service in non-interconnected areas with more than 11 years’ experience and operations in Inirida, Mitu, Guapi, Bahia Solano and Cupica, among others.
* Electrificadora del Meta (EMSA E.S.P.)[[19]](#footnote-19) operator in the municipality of La Macarena, Caquetá.
* SIGLO XXI S.A. E.S.P. Operator in the municipality of La Primarvera, Vichada and other surrounding towns.
* DISPAC S.A. E.S.P.[[20]](#footnote-20) distribuitor and supplier in 15 municipalities in the Chocó Departament.
* Empresa de Energía de Cundinamarca S:A E.S.P (E.E.C)[[21]](#footnote-21). and Codensa E.S.P[[22]](#footnote-22). , Power service operators in the Cundiamarca department, which covers areas that do not have access to interconnected networks but have not been declared as ZNIs.

The main conclusions of the interviews are as follows:

* The operators confirmed interest in making new investments for power generation capacity and the need to access credit under appropriate conditions in order to invest in renewable energies.
* The interviewed operators perceive the possibility of partnerships with private investors as an alternative to develop conventional power replacement with renewable energy projects.
* The most widely-accepted technology for operators is photovoltaic and hybrid, since they are the ones with operation information and technical data. This information is essential to support project guarantees for private investors and the commercial bank, which will eventually finance the investment demand.
* Operators are aware of market regulatory signals of the ZNIs regarding the promotion of energy delivery to these areas and are prepared to face these new challenges with renewable sources projects. They have pre-feasibility analysis, as is the case of GENSA with the solar generation plant in Inirida. Similarly, the case of medium-sized operators who intend to open power supply lines to non-interconnected zones but who are currently structuring previous projects or studies. Operators are dynamic and are managing new projects, but without sufficient resources to develop them because they only rely on resources from FAZNI, FAER or Royalty Funds, which do not cover the initial investments and are the highest of the projects (mainly with renewable energy technologies). Finally, there is a strong decision by some operators who want to stay within their region of influence to continue their positioning and recognition as the leading company that has brought energy solutions to the population.
* The biggest fear from operators is the uncertainty in receiving subsidy payments for the service, given the government's delay in disbursing resources to some areas.

# Results of Technology Provider Surveys

Below are the results of technology provider surveys.

In terms of headquarters locations, 50% of companies are located in the city of Medellin and its metropolitan area, followed by Bogota (21%), Cartagena (14%), Cali (7) and Barranquilla (7%).

Figure 20. Location of the technology providers per city. (Source: Compiled by author)

64% of those surveyed are renewable technology providers for the ZNI, as shown in Figure 21, but only 36% of those surveyed have developed any type of these projects in the ZNIs.

Figure 21. Suppliers that can offer renewable technologies. (Source: Compiled by author)

|  |  |
| --- | --- |
| SI | YES |
| NO | NO |

Figure 22. Suppliers that have developed projects in ZNIs. (Source: Compiled by author)

|  |  |
| --- | --- |
| SI | YES |
| NO | NO |

Figure 23. Departments where suppliers have developed projects. (Source: Compiled by author)

As shown in Figure 23, technology suppliers have developed projects in all ZNIs across the country, so there is sufficient coverage in the country for the development of projects.

Figure 24. Average value of implemented projects. (Source: Compiled by author)

|  |  |
| --- | --- |
| MENOS DE COP 500 | LESS THAN 500 COP |
| MAS DE COP 500 | MORE THAN 500 COP |
| ENTRE 1000 Y 2000 | BETWEEN 1000 AND 2000 |
| NR | NO RESPONSE |

For 56% of surveyed companies, the projects they have developed have been for amounts lower than USD$ 166,666, 11% have developed projects between US$ 325,567 and US$ 651,134 and 22% of those surveyed have developed projects for more than US$ 1,627,727. These values show that the size of projects developed in the ZNIs vary between 500 kW and 1 MW of power.

Figure 25 shows the distribution of companies per range of projects implemented, which fluctuates between the ranges of 1-10 of 44% of those surveyed, 10-20 with 11% of contacted companies. Meanwhile, 33% of those surveyed claim to have experience of more than 20 projects and the remaining 11% do not know or did not answer. Hibrytec SAS [[23]](#footnote-23)is the only company that has implemented more than 150 hybrid and solar projects.

Figure 25. Number of implemented projects. (Source: Compiled by author)

|  |  |
| --- | --- |
| DE 1 A 10 | FROM 1 TO 10 |
| MAS DE 20 | MORE THAN 20 |
| DE 10 A 20 | FROM 10 TO 20 |
| NR | NO RESPONSE |

The supplied technologies vary; however the case study validates the supply of 4 types of specific technology types, including conventional generation. To consolidate the supply by type, as shown in Figure 26, the most offered are hybrid solar systems with fuel. Biomass is the least-supplied technology.

Figure 26. Supply per technology. (Source: Compiled by author)

|  |  |
| --- | --- |
| DIESEL  | DIESEL  |
| HIBRIDA | HYBRID |
| SOLAR | SOLAR |
| BIOMASA | BIOMASS |
| NO | NO |
| SI | YES |

100% of these are interested in evaluating projects in ZNIs. The most attractive contracting models are shown in Figure 26. The figure shows that the sales model is appropriate for 100% of operators, for 78% it would be viable to develop projects with Leasing or PPA models, 67% of them would be viable with the Public Private Partnership (PPP) model. In the latter mode, they say that some conditions must be defined to be able to set up these contracts. The main concern of companies in accepting a generation contract is the payment source, since it is the distribution and commercialization operator who covers the monetary sources through rates and subsidies.

Figure 27. Contract model to supply technology in the ZNIs. (Source: Compiled by author)

|  |  |
| --- | --- |
| NO | NO |
| SI | YES |
| BAJO MODELO DE VENTA | UNDER SALES MODEL |
| BAJO MODELO DE LEASING | UNDER LEASING MODEL |
| BAJO MODELO DE PPA | UNDER PPA MODEL |
| BAJO MODELO APP | UNDER PPP MODEL |

When asked about barriers to entry in this sector, 67% of those surveyed mentioned sector regulations that are unclear and tend to vary easily as the most important factors.

Legal risks are of moderate priority for companies. Finally, the results show that financial risks are not very relevant to enter into renewable energy projects.

Among the comments and answers to another type of barrier, there were answers that refer to the need to have guarantees that allow free competition between tenders, since there is no transparency in these processes.

Figure 28. Barriers to entry in the ZNIs (Non-interconnected zones) (Source: Compiled by author)

|  |  |
| --- | --- |
| RIESGOS SOBRE LA REGULACION DEL SECTOR | RISKS  |
| RIESGOS LEGALES | LEGAL RISKS |
| RIESGO FINANCIERO | FINANCIAL RISKS |
| NO SABE/NORESPONDE | DOESN'T KNOW/NO RESPONSE |
| BAJO | LOW |
| MODERADO | MODERATE |
| MEDIO | MEDIUM |
| ALTO | HIGH |

Companies supplying technology and energy services perceive that the main risks of doing business with operators in non-interconnected zones is the uncertainty of the payment source and the type of contract to be made.

Regarding financial risks, there is no noticeable trend. Moreover, within the comments received and answers regarding another type of risk, some comments were received expressing concerns about the improper handling of resources by some leaders of these areas, which constitutes a risk for power generation for potential operators.

# Results of Interviews with Technology Providers.

Interviews were done with the following technology supply companies.

* HMV Ingenieros,[[24]](#footnote-24) , a company dedicated to the construction of small hydropower plants, recognized in the trade as a reputable company to develop energy projects.
* GENMAS S.A[[25]](#footnote-25)., is a construction company for energy projects mainly in Antioquia, a mixed company that has had major involvement in some Antioquia municipalities.
* Supernova-Energy Services[[26]](#footnote-26), , a company dedicated to the structuring of hybrid solar technology projects. This company presents project developments with combinations of GLP and has had ties with the ZNIs.

From interviews with these companies, we can see the following issues that are important to consider:

* All companies in the sector have had plans to structure projects with a portion of credit. However, the loan conditions in commercial banks are not feasible due to high interest rates and the maximum period of 5 years.
* One aspect that everyone thinks is the best way to venture into these zones, is through PPP models in partnership with local operators. In this way, each company would focus on their business strength.
* In the case of HMV Ingenierros and Genmas, they are willing to evaluate opportunities to enter into the power generation business. For Supernova ES business has been more focused on bringing development proposals to state entities. Additionally, alternatives have been evaluated to replace it with GLP, these initiatives have been promoted by producers of this fuel type, since it is argued that it has environmental and logistical benefits. These considerations have also been presented to the authorities and are still under study.

Figure 29. Higher risks for the development of projects in ZNIs.

|  |  |
| --- | --- |
| INCERTIDUMBRE EN LAS FUENTES DE PAGO | PAYMENT SOURCE UNCERTAINTY |
| TIPOS DE CONTRATOS | CONTRACT TYPES |
| FINANCIEROS | FINANCIAL |
| NO SABE/NO RESPONDE | DOESN'T KNOW/NO RESPONSE |
| BAJO | LOW |
| MODERADO | MODERATE |
| MEDIO | MEDIUM |
| ALTO | HIGH |

100% of those interviewed would be interested in analyzing the possibility of taking a portion of credit to leverage the operation in non-interconnected zones. To do this, they ask them what would be the most relevant credit variables and conditions to take into account and make power generation with renewable sources in ZNI an attractive idea.

Figure 30. Most important aspects to get credit.

|  |  |
| --- | --- |
| GARANTIAS | GUARANTEES |
| TASA | RATE |
| PLAZO DEL CREDITO | CREDIT TERM |
| NO SABE/ NO RESPONDE | DOESN'T KNOW/NO RESPONSE |
| BAJO | LOW |
| MODERADO | MODERATE |
| MEDIO | MEDIUM |
| ALTO | HIGH |

89% of those interviewed said that the interest rate has a significant influence on the financial analysis results, since so far they a high risk premium has been attached on account of the uncertainty of payments perceived by the commercial bank.

In addition, credit terms have been decisive since the investments needed are long-term and currently the bank has no options to extend the periods beyond 5 years.

Finally, the guarantees requested by commercial banks as Local Financial Institutions are critical to the financial viability of each company model. These guarantees are once again linked with the uncertainty of payments arising from the current generation model in ZNIs.

The average range of financial resources that these companies will require from the bank is between US$ 325,540 and US$ 1,627,701, as shown in the following chart. This amount can vary depending on technology costs and the credit conditions.

# Results of Interviews with Local Financial Institutions

Interviews were done with two commercial banks, Bancolombia and Banco Procredit. In explaining the purpose of the project, both expressed interest in financing investment projects in renewables in the ZNIs from two different approaches.

Bancolombia is interested through traditional financing of its clients, but also using leasing lines accepted by the technology as part of the guarantee for loans. Furthermore, it is interested in developing the project financing through fiduciary assignments or pension trusts to guarantee payments and so that captured subsidy flows can be paid in through these debt repayment mechanisms.

For its part, Banco Procredit is interested in participating in a pure Project Finance (PF) model. The features of the projects that they are interested in financing are as follows:

Range of Projects: Small-scale 1-5 MW

Investment range 50 Million COP to 7 billion COP

Environmental Unit: 3 people – 3 specialists

General credit conditions are: 8 years, can be longer terms, DTF rate + negotiated points 4 to 8 points depending on the client. Up to 2 years grace period.

The guarantee requirements are up to 80% of the credit value; in the case of solar power, FV can be used as a guarantee.

They do not do leasing operations, [which] requires 20% of minimum equity for loans and 30% for PF operations.

Using the cascade principle: all power is paid through a bank account and sets fees according to expected generation curves.

The bank carries out the project’s legal and financial due diligence studies but the client must assume the costs of technical due diligence.

They find an excess of liquidity in the market and for this reason prefer to use their own resources and believe that a guarantee fund would help to resolve one of the most important barriers to this type of project that is related to the size of businesses that develop them. Additionally, they also believe that some projects need technical assistance resources for better structuring.

# Conclusions

According to the information available in the IPSE, the entire market in the Non-Interconnected Zones is composed of 1,118 locations that are found in the ZNIs in which 1,414 motors with a total power of 261.6 MWe are installed. Of this power, 9.1 MWe are renewable, with the real portion of renewable energies being barely 3.5%.

According to the CREG information, a total of 94 operators offer services in the ZNIs. As per the information registered in the database of the Superintendent of Domestic Public Services and the operators that presented reports in 2014 (65 in total), the total of users in the ZNIs rises to 180,338.

The majority of the communities (86%) have less than 100kW of power installed and 11% have installed between 100 and 1,000 kW.

Forty-three (43) communities were selected as targets for the study of the market that has an installed power of 158 MWe, equivalent to 60% of the total power installed in the ZNIs. The energy generated in these locations in 2013 rose to 464 GWh, which surpasses the energy billed in 2013 due to the fact that the amounts of reactive energy and losses in distribution are included in the generation records.

In total, in the 43 communities selected, 37 operators provide services. The users served by these businesses rises to 128,078, which is equivalent to 71% of the users with service in the ZNIs. The aforementioned leads to the conclusion that 39% of the operators have 71% of the users, for which reason they have greater possibility and potential to develop renewable energy projects in the ZNIs.

In agreement with the information on energy generation reported by IPSE, in the 43 communities that rely on telemetering, the consumption of diesel in 2013 was 36.97 million gallons and emissions were 375,650 tons of CO2.

The generation of energy in 2013, according to the information reported by IPSE, was 464 GWh. Based on this amount and taking into account the criteria for carrying out the forecast, in 2040 the energy generated in these communities would be greater than 1,4000 GWh/year. In 2040 it is forecasted to reach an installed power close to 270 MWe in the communities selected as the objective of analysis.

The new power required in 2040 is close to 80 MWe and the renewable portion in this scenario for the group of communities selected as the objective of analysis reaches the goal of 30% of that foreseen by the government in the PROURE plan for 2020.

In the first four years, a time in which the financing program would operate, the installation of 8.8 MWe is required, which requires an investment of 28.3 billion $US, of which it is considered that the program would put forth 19.265 billion $US, with a de facto leverage of 0.3 financing of the first-level financial intermediaries *and investor equity*.

With the forecasts carried out, the project allows for a savings of close to 600 million dollars in the period of technological evaluation (25 years). According to the project agreement, the cumulative reduction of emissions with the renewable power that is projected to be installed is 1,200,000 tons of CO2 in 25 years (service life of the technologies).

From the operator and technology provider surveys, it can be concluded that:

Half of the operators are of mixed or private nature and their contract system is private and, therefore, they can access credit with the commercial bank and can access resources by way of Bancoldex.

79% of the businesses surveyed affirm that they have plans to expand the installed power. Additionally, of the total of operators that wish to broaden their installed capacity, 45% have planned to do it with sources of renewable energy, 34% are thinking of constructing new generation capacity with conventional sources of energy and only 11% are indifferent to the type of energy solution due to being net marketers or distributors. The most popular non-conventional energy source among those surveyed is photovoltaic and hybrid.

55% of the operators consider their source of financing to be state funds (FAZNI and FAER) and 45% consider obtaining resources from other sources for the service expansion projects. In particular they are considering looking for credit in the marketplace. On the question of if they have considered the participation of third parties in the expansion of generation capacity, 45% have not considered it, 36% have evaluated this possibility and 18% do not know.

Among the renewable energy investment projects that are reported are a solar park for Amazonas, a solar park for Inirida and a SHP for Jurado. These projects require resources of approximately 9.269 million US dollars.

Twenty-one (21) percent of those surveyed consider the greatest barrier to developing generation projects with renewable energy to be the lack of financial resources; 14% believe that it is the lack of regulation of the sector; and 14% consider

it to be the lack of support from IPSE.

With respect to the results of the surveys of technology providers, the most important results are summarized below.

For 56% of the businesses, the projects that have been developed have been done for an amount less than 162,770 $US; 11% have developed projects between US$ 325,540 and US$ 651,080; and 22% of those surveyed have developed projects for more than US$ 1,627,770. These amounts demonstrate that the size of the projects that are developed in the ZNIs vary between 500 kW and 1 MW of power.

One hundred percent of them are interested in evaluating the possibility of investing in projects in the ZNIs. The technology sales model is appropriate for 100% of the operators. For 78% it would be viable to develop projects with Leasing or PPA models. For 67% of them the Public Private Partnership (PPP) model would be viable.

The technology and energy service provider businesses perceive the principal risks of doing business to be with operators of the non-interconnected zones. They are uncertain about the source of payment and type of contract to be entered into.

One hundred percent of those interviewed would be interested in analyzing the possibility of taking a portion of the credit for leveraging the operation in the ZNIs. Eighty-nine percent of those surveyed guarantee that the interest rate has a great influence on the financial analysis results, since until now a high-risk premium has been imposed upon them due to the uncertainty of the payments that the commercial bank receives.

As far as the Local Financial Institutions:

For its part Banco Procredit has interest in participating in a pure Project Finance model.

Bancolombia, as a commercial bank, is interested in financing generation in the ZNIs by way of traditional financing of its clients but also by using the leasing lines that accept technology as part of the loan guarantee. Likewise, it is interested in developing financing projects by way of trust accounts or independent property that allow for the guarantee of payments and that the subsidy flows that they can capture come in by way of these mechanisms to repay the debt.

Both banks consider the option of accessing short and long-term funding to be very attractive for promoting investments in renewable energy in the ZNIs.

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SOPESA. San Andres solid urban waste incineration plant.

# Appendixes

# Appendix 1. Database of Operators in the ZNIs in accordance with the CREG.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Name** | **Tax ID#** | **City** | **Department** |
| 1 | SOCIEDAD ANÓNIMA ENERGÍA PARA EL AMAZONAS S.A. E.S.P. | 9003391744 | Leticia  | Amazonas |
| 2 | EMPRESA DE ENERGIA DEL AMAZONAS S.A. E.S.P. | 8000336232 | Leticia  | Amazonas |
| 3 | EMPRESA DE ENERGIA ELECTRICA DE SERVICIOS PUBLICOS E.S.P DEL MUNICIPIO DE MURINDO | 8110340775 | Murindo  | Antioquia |
| 4 | EMPRESAS PÚBLICAS MUNICIPALES DE URRAO E.S.P. | 8001522942 | Urrao  | Antioquia |
| 5 | EMPRESA MUNICIPAL DE SERVICIOS PUBLICOS DOMICILIARIOS DE VIGIA DEL FUERTE | 8110087758 | Vigía Del Fuerte  | Antioquia |
| 6 | SOCIEDAD PRODUCTORA DE ENERGIA DE SAN ANDRES Y PROVIDENCIA S.A. E.S.P. SOPESA | 8270001087 | San Andres  | Archipiélago De San Andres, Providencia Y Santa Catalina |
| 7 | ELECTRIFICADORA DE MAPIRIPAN S.A. E.S.P. | 9004323683 | Bogotá  | Bogotá |
| 8 | COMITE PROELECTRICO ARCHIPIELAGO DE SAN BERNARDO E ISLOTE | 9001329361 | Cartagena De Indias  | Bolívar |
| 9 | COOPERATIVA COMUNITARIA DE SERVICIOS PÚBLICOS DE ISLA FUERTE | 9001418021 | Cartagena De Indias  | Bolívar |
| 10 | MUNICIPIO DE BELEN DE LOS ANDAQUIES | 8000957347 | Belén De Los Andaquies  | Caquetá |
| 11 | EMPRESA DE SERVICIOS DE CURILLO ESERCU S.A. E.SP | 8280013081 | Curillo  | Caquetá |
| 12 | MUNICIPIO DE CURILLO - CAQUETA | 8000957576 | Curillo  | Caquetá |
| 13 | MUNICIPIO DE EL PAUJIL | 8000957630 | El Paujil  | Caquetá |
| 14 | GENDECAR S.A. E.S.P | 9002823704 | Florencia  | Caquetá |
| 15 | MUNICIPIO DE LA MONTAÝITA - CAQUETA | 8000957702 | La Montanita  | Caquetá |
| 16 | EMPRESA DE SERVICIOS PUBLICOS DE SAN ANTONIO DE GETUCHA S.A. E.S.P | 9000808027 | Milan  | Caquetá |
| 17 | MUNICIPIO DE PUERTO RICO CAQUETA | 8000957759 | Puerto Rico  | Caquetá |
| 18 | MUNICIPIO SAN VICENTE DEL CAGUAN | 8000957852 | San Vicente Del Caguan  | Caquetá |
| 19 | ASOCIACION DE USUARIOS DE ENERGIA ELECTRICA DE ARARACUARA | 9001735735 | Solano  | Caquetá |
| 20 | EMPRESA MUNICIPAL DE SERVICIOS PUBLICOS DE OROCUE SA ESP | 9002519551 | Orocue  | Casanare |
| 21 | EMPRESA DE ENERGÍA ELÉCTRICA DE GUAPI S.A. E.S.P. | 8350001427 | Guapi  | Cauca |
| 22 | COOPERATIVA DE SERVICIOS PÚBLICOS DE LÓPEZ DE MICAY | 9001224359 | López De Micay  | Cauca |
| 23 | EMPRESA MIXTA DE SERVICIOS PUBLICOS DE ENERGIA ELECTRICA DE TIMBIQUI. | 8170004877 | Timbiqui  | Cauca |
| 24 | EMPRESA MIXTA DE SERVICIOS DE ENERGÍA ELÉCTRICA DE ACANDI E.S.P | 8180002939 | Acandi  | Choco |
| 25 | JUNTA ADMINISTRADORA DE SERVICIO PÚBLICOS DE CAPURGANA | 8180002763 | Acandi  | Choco |
| 26 | COOPERATIVA DE SERVICIOS PUBLICOS DE CUPICA | 9000086136 | Bahía Solano  | Choco |
| 27 | EMPRESA DE SERVICIOS PÚBLICOS DE BAHÍA SOLANO S.A. E.S.P. | 8180002638 | Bahía Solano  | Choco |
| 28 | ASOCIACION DE USUARIOS DE SERVICIOS PUBLICOS DE LAS COMUNIDADES DE LA ZONA SUR DEL MUNICIPIO DE BAJO BAUDO | 9005349910 | Bajo Baudo  | Choco |
| 29 | EMPRESA DE ENERGIA ELECTRICA DE PIZARRO S.A. E.S.P. | 8180002029 | Bajo Baudo  | Choco |
| 30 | ASOCIACION DE USUARIOS DE SERVICIOS PUBLICOS DE BELLAVISTA | 9001914274 | Bojaya  | Choco |
| 31 | COMPAÝIA DE SERVICIOS PUBLICOS DOMICILIARIOS DE BOJAYA | 9005195391 | Bojaya  | Choco |
| 32 | EMPRESA MIXTA DE ENERGIA DE BOJAYA S.A. E.S.P. | 8180024332 | Bojaya  | Choco |
| 33 | MUNICIPIO DEL CARMEN DEL DARIEN | 8180013419 | Carmen Del Darién  | Choco |
| 34 | ALCALDIA MUNICIPAL DEL CANTON DEL SAN PABLO | 8002394145 | El Cantón Del San Pablo  | Choco |
| 35 | UNIDAD DE SERVICIOS PUBLICOS DE ENERGIA, ACUEDUCTO, ALCANTARILLO Y ASEO DEL MUNICIPIO LITORAL DEL SAN JUAN | 8180000022 | El Litoral Del San Juan  | Choco |
| 36 | MUNICIPIO DE ISTMINA | 8916800672 | Istmina  | Choco |
| 37 | ALCALDIA MUNICIPAL DE LLORO | 8916802812 | Lloro  | Choco |
| 38 | MUNICIPIO DEL MEDIO ATRATO | 8180009413 | Medio Atrato  | Choco |
| 39 | ASOCIACIÓN DE USUARIOS DE SERVICIOS PÚBLICOS DEL MEDIO BAUDO E.S.P. | 9002749029 | Medio Baudo  | Choco |
| 40 | MUNICIPIO DEL MEDIO SAN JUAN | 8180012062 | Medio San Juan  | Choco |
| 41 | MUNICIPIO DE NOVITA | 8916800751 | Novita  | Choco |
| 42 | EMPRESA DE ENERGIA ELECTRICA DEL MUNICIPIO DE NUQUI S.A. E.S.P | 8180001661 | Nuqui  | Choco |
| 43 | GESTIONES INTEGRALES DE OCCIDENTE SAS ESP | 9002173011 | Quibdó  | Choco |
| 44 | MUNICIPIO DE ALTO BAUDO | 8916000624 | Quibdó  | Choco |
| 45 | MUNICIPIO DEL RIO IRO | 8180012030 | Rio Iro  | Choco |
| 46 | MUNICIPIO DEL RIO QUITO | 8180008991 | Rio Quito  | Choco |
| 47 | MUNICIPIO DE RIOSUCIO | 8916800790 | Riosucio  | Choco |
| 48 | ELECTRIFICADORA DEL MUNICIPIO DE RIOSUCIO CHOCO S.A. E.S.P | 8180001923 | Riosucio  | Choco |
| 49 | ALCALDIA MUNICIPAL DEL MUNICIPIO DE SIPI | 8000956134 | Sipi  | Choco |
| 50 | EMPRESA DE SERVICIOS PUBLICOS DOMICILIARIOS DE UNGUIA S.A E.S.P | 9003040175 | Unguia  | Choco |
| 51 | EMPRESA DE ENERGÍA DEL GUAINÍA LA CEIBA S.A. E.S.P. | 8430000578 | Inírida  | Guainía |
| 52 | MUNICIPIO DE MIRAFLORES GUAVIARE | 8001031984 | Miraflores  | Guaviare |
| 53 | JUNTA DE SERVICIOS PUBLICOS DEL MUNICIPIO DEL CALVARIO | 8920990011 | El Calvario  | Meta |
| 54 | EMPRESA DE SERVICIOS DE ENERGÍA ELÉCTRICA Y VARIOS DE LA MACARENA | 8220016101 | La Macarena  | Meta |
| 55 | EMPRESA DE SERVICIOS PUBLICOS MUNICIPALES DE MAPIRIPAN | 8220017091 | Mapiripan  | Meta |
| 56 | PERLA DEL MANACACIAS E.S.P. | 8220014681 | Puerto Gaitán  | Meta |
| 57 | MUNICIPIO DE PUERTO RICO META | 8000981950 | Puerto Rico  | Meta |
| 58 | ASOCIACION DE USUARIOS DE SERVICIOS PUBLICOS DOMICILIARIOS DE BARRANCOMINAS | 9000302292 | Villavicencio  | Meta |
| 59 | ASOCIACION DE USUARIOS DEL SERVICIO DE ENERGIA ELECTRICA DE PUERTO ALVIRA | 8220053135 | Villavicencio  | Meta |
| 60 | EMPRESA DE SERVICIOS PUBLICOS DE ENERGIA ELECTRICA DEL MUNICIPIO DE BARBACOAS S.A. E.S.P. | 9003500235 | Barbacoas  | Nariño |
| 61 | MUNICIPIO DE BARBACOAS - NARIÑO | 8000990617 | Barbacoas  | Nariño |
| 62 | MUNICIPIO DE CUMBAL | 8000990663 | Cumbal  | Nariño |
| 63 | ASOCIACION DE ENERGIA DE LAS ZONAS RURALES DEL MUNICIPIO DE EL CHARCO | 9004282705 | El Charco  | Nariño |
| 64 | EMPRESA ASOCIATIVA DE TRABAJO ENERGÍA DEL SUR | 9003520551 | El Charco  | Nariño |
| 65 | EMPRESA GENERADORA DE ENERGÍA ELÉCTRICA DE EL CHARCO S.A. E.S.P. | 8400000355 | El Charco  | Nariño |
| 66 | EMPRESA DE ENERGIA DE SALAHONDA S.A. E.S.P. | 8400002036 | Francisco Pizarro  | Nariño |
| 67 | EMPRESA ASOCIATIVA DE TRABAJO PARA LA PRESTACION DEL SERVICIO DE ENERGIA ELECTRICA EN LA PARTE BAJA DE LA TOLA | 9005113073 | La Tola  | Nariño |
| 68 | EMPRESA DE ENERGIA ELECTRICA DE LA TOLA | 8400000362 | La Tola  | Nariño |
| 69 | EMPRESA ASOCIATIVA DE TRABAJO EL PORVENIR E.S.P. | 8400000710 | Mosquera  | Nariño |
| 70 | E.A.T. ELECTRIFICADORA DE ENERGIA ELECTRICA DEL MUNICIPIO DE OLAYA HERRERA | 9001292759 | Olaya Herrera  | Nariño |
| 71 | MUNICIPIO OLAYA HERRERA | 8000991131 | Olaya Herrera  | Nariño |
| 72 | EMPRESA DE ENERGIA ELECTRICA DEL MUNICIPIO DE ROBERTO PAYAN S.A.S E.S.P | 9002635701 | Roberto Payan  | Nariño |
| 73 | E.A.T. DE PRESTACION DE SERVICIOS PUBLICOS DE LA LOCALIDAD DEL CHAJAL MUNINIPIO DE TUMACO | 8400007764 | San Andres De Tumaco  | Nariño |
| 74 | ASOCIACION DE USUARIOS DEL SERVICIO DE ENERGIA ELECTRICA DE LA ZONA RURAL DE SANTA BARBARA DE ISCUANDE | 9002608574 | Santa Bárbara  | Nariño |
| 75 | ELECTROISCUANDE S.A.S. E.S.P | 9006394112 | Santa Bárbara  | Nariño |
| 76 | EMPRESA ASOCIATIVA DE TRABAJO PARA PRESTACION DEL SERVICIO DE ENERGIA ELECTRICA EN EL RIO ISCUANNDE | 9005039172 | Santa Bárbara  | Nariño |
| 77 | MULTISERVICIOS DE ISCUANDE S.A. E.S.P | 9006627905 | Santa Bárbara  | Nariño |
| 78 | MUNICIPIO DE ORITO | 8001028962 | Orito  | Putumayo |
| 79 | MUNICIPIO DE PUERTO ASIS | 8912004613 | Puerto Asís  | Putumayo |
| 80 | EMPRESA SOLIDARIA DE SERVICIOS PUBLICOS AGUA VIVA DE PUERTO GUZMAN E.S.P. | 9000159795 | Puerto Guzman  | Putumayo |
| 81 | MUNICIPIO DE PUERTO GUZMAN | 8002224892 | Puerto Guzman  | Putumayo |
| 82 | EMPRESA DE SERVICIOS PUBLICOS DOMICILIARIOS DE PUERTO LEGUIZAMO | 8460000214 | Puerto Leguizamo  | Putumayo |
| 83 | ALCALDIA MUNICIPAL DE BUENAVENTURA - VALLE DEL CAUCA | 8903990453 | Buenaventura  | Valle Del Cauca |
| 84 | ASOCIACION DE USUARIOS DEL SERVICIO DE ENERGIA ELECTRICA DE PUERTO MERIZALDE | 8350008044 | Buenaventura  | Valle Del Cauca |
| 85 | ELECTRIFICADORA DEL PACÍFICO S.A. E.S.P. | 9000390075 | Buenaventura  | Valle Del Cauca |
| 86 | ELECTRIFICADORA E ILUMINACIONES DEL VALLE S.A.S E.S.P | 9006672337 | Buenaventura  | Valle Del Cauca |
| 87 | EMPRESA ASOCIATIVA DE TRABAJO ELECTROSOLEDAD DE ISCUANDE | 9004702569 | Cali  | Valle Del Cauca |
| 88 | EMPRESA ASOCIATIVA DE TRABAJO ENERGIA DE OLAYA HERRERA EAT ENEROLAYAHERRERA E.S.P | 9007026845 | Cali  | Valle Del Cauca |
| 89 | EMPRESA DE ENERGÍA DE MAGUI PAYAN S.A. E.S.P. | 8400009294 | Cali  | Valle Del Cauca |
| 90 | EMPRESA DE SERVICIOS PUBLICOS DEL OCCIDENTE COLOMBIANO S.A. | 9006620757 | Cali  | Valle Del Cauca |
| 91 | ALCALDIA MUNICIPAL DE CARURU | 8320006054 | Caruru  | Vaupés |
| 92 | DEPARTAMENTO DEL VAUPES | 8450000210 | Mitú  | Vaupés |
| 93 | MUNICIPIO DE TARAIRA | 8320002194 | Taraira  | Vaupés |
| 94 | EMPRESA DE ENERGÍA ELÉCTRICA DEL DEPARTAMENTO DEL VICHADA S.A. E.S.P. | 8420001558 | Puerto Carreño  | Vichada |

# Appendix 2. Technology Provider Database

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Name** | **City Headquarters** | **Department** | **Address** | **Telephone** | **Web Page** | **Email Address** | **Technology Offered** |
| CUMMINS DE LOS ANDES | MEDELLIN | ANTIOQUIA | Not defined | 573112877837 | <http://www.cumandes.com/html/energia.html> | dmora@equitel.com.co | GENERATION MOTORS |
| HYBRYTEC | MEDELLIN | ANTIOQUIA | CR 42 54 A 155 | 5744440520 | <http://www.hybrytec.com/> | info@hybrytec.com  | SOLAR PANELS |
| ENERGREENCOL | CARTAGENA | BOLICAR | BOSQUE SECTOR SAN ISIDRO PRIMERA LABRADOR # 53 44 | 3007538571 | <http://www.energreencol.com/> | jose.arrieta@energreencol.com | RENEWABLE ENERGY CONSULTANCY |
| GECOLSA | SABANETA | ANTIOQUIA | CR 48 55 SUR 56 | 5744485200 | [https://gecolsa.com](https://gecolsa.com/)  |   | ELECTRICITY GENERATION |
| APROTEC | CALI | VALLE DEL CAUCA | CL 15 B NORTE 9 A NORTE 42 | 5726535797 | <http://www.aprotec.com.co/> | tecnoapropiada@hotmail.com  | RENEWABLE ENERGY SUPPLIER |
| INGESOLAR | BOGOTA | CUNDINAMARCA | CR 25 18 70 PALOQUEMAO | 5712770719 | <http://ingesolar.com.co/> | ingesolar\_uno@hotmail.com | SOLAR PANELS |
| GREENENERGY LATINAMERICA | CARTAGENA | BOLICAR | Cl 6 3 17 BOCAGRANDE | 3176409377 | <http://www.greenenergy-latinamerica.com/> |   | RENEWABLE ENERGY SUPPLIER |
| ENERGIA Y POTENCIA | MEDELLIN | ANTIOQUIA | CR 48 20 255 | 5742626623 | [http://www.energiaypotencia.com](http://www.energiaypotencia.com/) |   | MOTOR GENERATOR MARKETER  |
| GIE SAS | BOGOTA | CUNDINAMARCA | CL 111 51 30 | 5714660161 | [http://gie.com.co](http://gie.com.co/) | giesa@gie.com.co  | RENEWABLE ENERGY SUPPLIER |
| MH ENERGIA SOLAR SAS | BARRANQUILLA | ATLANTICO | CL 37 43 164 | 5753403302 | <http://www.mhenergiasolar.com.co/> | info@mhenergiasolar.com.co  | SOLAR PANELS |
| HMV INGENIEROS | MEDELLIN | ANTIOQUIA | CR 43 A 11 A 80 | 5743706666 | <http://www.h-mv.com/> |   | SMALL HYDROELECTRIC POWER PLANTS |
| HEMEVA | BOGOTA | CUNDINAMARCA | CR 66 A 12 65 | 5714136282 | http://www.hemeva.com/ |   | RENEWABLE ENERGY SUPPLIER |
| SUPERNOVA ENERGY SERVICES | MEDELLIN | ANTIOQUIA | CL 7 39 215 | 5743111854 | <http://www.supernova-es.com/> |   | RENEWABLE ENERGY SUPPLIER |
| ESENERGY | BOGOTA | CUNDINAMARCA | CR 24 2 18 | 5712895437 | <http://esenergy.com.co/> | info@esenergy.com.co | SOLAR PANELS |
| WARTSILA | BOGOTA | CUNDINAMARCA | CR 19 B 83 63 | 5716358168 | <http://www.wartsila.com/col> |   | GENERATION MOTORS |

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| Appendix 3. Survey Format  |
|   | **GENERAL INFORMATION** |
| 1 | Company Name **(Select the name of your company)** |   |
| 2 | Tax ID#  |   |
| 3 | Municipality/ Area in which it provides service |   |
| 4 | Type of Company**(Mark with an X)** | Public |   | Private |   | Mixed |   |
| 5 | Services offered **(Mark with an X)** | Production |   | Distribution |   | Supply |   |
|   | **GENERATION INFORMATION** |
| 6 | Total Generation Capacity | kW |   |
| 7 | Unit 1 | kW |   | Technology |   |
| 8 | Unit 2 | kW |   | Technology |   |
| 9 | Unit 3 | kW |   | Technology |   |
| 10 | Unit 4 | kW |   | Technology |   |
| 11 | Annual Production | kWh/year |   |
| 12 | Annual fuel consumption.  | Gallon/Year |   |
| 13 | Total fuel cost **(Amounts in Billions)** | B$/year |   |   |   |   |   |   |   |
| 14 | Total maintenance cost **(Amounts in Billions)** | B$/year |   |   |   |   |   |   |   |
| 15 | Actual generation cost  | $/Kwh |   |
| 16 | Fuel cost  | $/kWh |   |
| 17 | AOM Costs  | $/kWh |   |
| 18 | How to consider the performance of current systems **(Mark with an X)** | Good |   | Fair |   | Bad |   |
|   | **DISTRIBUTION INFORMATION** |
| 19 | Distribution Networks **(Linear Distance)** | Km |   |   |   |   |   |   |   |
| 20 | Distribution voltage  | V |   |   |   |   |   |   |   |
| 21 | Percentage of Loss in Distribution | % |   |   |   |   |   |   |   |
|   | **INFORMATION REGARDING THE SUPPLY** |
| 22 | No. of Residential Users Served | Level 1 |   | Level 2 |   | Level 3 |   | Level 4 |   |
| 23 | No. of Non-residential Users | Business |   | Industrial |   |   |   |   |   |
| 24 | Percentage of Users with micro measuring  | Yes | % | No | % |
| 25 | Average Monthly Billing **(Amounts in Pesos)** | $/month |   |
| 26 | Average Monthly Payment **(Amounts in Pesos)** | $/month |   |
| 27 | Subsidies charge **(Amounts in pesos)** | $/month |   |
|   | **FINANCIAL INFORMATION** |
| 28 | Total assets**(Amounts in Billions)** | B$ |   |
| 29 | Total liabilities **(Amounts in Billions)** | B$ |   |
| 30 | Total income **(Amounts in Billions)** | B$/year |   |
| 31 | Income for invoicing energy to users **(Amounts in Billions)** | B$/year |   |
| 32 |  Income from subsidies **(Amounts in Billions)** | B$/year |   |
|   |   |
| 33 | Does the business have plans to broaden the generation capacity or improve the efficiency of its current generation systems? **(Mark your response with an X)** | YES |   | NO |   |
| 34 | **If the response is YES, please go to the Investment Projects section** | **If the response is NO, please respond to the following questions** |
| 35 | What is the reason for not making investments in new generation capacity or improving the efficiency of the current generation systems? **(Mark with an X)** | Not necessary |   | Doesn't have financial capacity |   | Doesn't have technical capacity |   | Other |   |
| 36 | If the response is other, specify the reason |   |
| 37 | What reasons would make your company decide to invest in expanding the capacity, improving efficiency of the current systems, or installing renewable energy systems? |   |
|   |   |
|   | **INVESTMENT PROJECTS IN ENERGY GENERATION EXPANSION** |
| 38 | Does the business forecast expanding the generation capacity?**(Mark with an X)** | YES |   | NO |   |
| 39 | Power that you plan to install? | kW |   |
| 40 | What type of technology do you plan to install? **(Mark with an X)** | Diesel |   | Renewable |   |
| 41 | Describe the type of renewable technology that you plan to install |   |
| 42 | How much do you estimate for the investments in generation capacity increase **(Figures in Billions)** | B$ |   |
| 43 | What percentage of investments are with renewable technology | % |   |
| 44 | How do you plan to finance the investments **(Mark with an X)** | Equity |   | Loans |   | State Funds |   |
| 45 | Have you explored the possibility of a private business making the required investments in the capacity expansion? **(Mark with an X)** | YES |   | NO |   |
| 46 | Describe the type of contractual framework that you have put forth to develop investments with a private party |   |
| 47 | Describe what your business has found to be the principal barriers to making investments in renewable technologies.  |   |
| 48 | Describe what your business has found to be the principal barriers to private businesses investing in renewable generation technologies in the ZNIs.  |   |
| 49 | **Name of survey respondent** |   |
| 50 | **Telephone** |   |
| 51 | **Email** |   |

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|   | **SURVEY OF BUSINESSES PROVIDING TECHNOLOGY AND SERVICES IN ZNIs** |
|   |
|   | **GENERAL INFORMATION** |
| 1 | Company Name |   |
| 2 | TaxID **(Input the TaxID without periods or verification digits** |   |
| 3 | Do you sell generation technology for the Non-Interconnected Zones? **(Mark with an X)** | YES |   | NO |   |
| 4 | Have you developed ER projects in the Non-Interconnected Zones? **(Mark with an X)** | YES |   | NO |   |
| 5 | How many projects have you developed in recent years? **(Mark with an X)** | 1 to 10 |   | 10 to 20 |   | more than 20 |   |
| 6 | What is the average amount of projects **(Amounts in Millions of pesos)** | >500 |   | >2000 |   | > 5000 |   |
| 7 | In what regions **(Municipality, Department)** have you developed these projects? **(Please separate each region with ; )** |   |
|   | **INFORMATION ABOUT TECHNOLOGY THAT YOU PROVIDE** |
| 8 | Diesel Generation Technology **(Select with an X)** | YES |   | NO |   |
| 9 | Renewable Generation Technology **(Mark with an X)** | YES |   | NO |   |
| 10 | Type of Renewable Technology **(Mark with an X and select each one of the characteristics of the technology that you offer)** |
| 11 | Solar |   | Isolated |   | Connected to the Network |   | Hybrid |   |
| 12 | Wind |   | Isolated |   | Connected to the Network |   | Hybrid |   |
| 13 | Biomass |   | Combustion |   | Gasification |   | Other |   |
| 14 | Small Hydroelectric Power Plants |   | Isolated |   | Connected to the Network |   | Hybrid |   |
| 15 | Biogas |   | Motors |   | Turbines |   | Others |   |
| 16 | Other Technology | Which? |   |
|   | **INDICATIVE INVESTMENT COST INFORMATION**  |
| 17 | Diesel Production | US$/KW Installed |   |
| 18 | **Renewable Energy** | **US$/kW** |
| 19 | Solar | Isolated |   | Connected to the Network |   | Hybrid |   |
| 20 | Wind | Isolated |   | Connected to the Network |   | Hybrid |   |
| 21 | Biomass | Combustion |   | Gasification |   | Other |   |
| 22 | Small Hydroelectric Power Plants | Isolated |   | Connected to the Network |   | Hybrid |   |
| 23 | Biogas | Motors |   | Turbines |   | Others |   |
|   | **INDICATIVE O&M COST INFORMATION** |
| 24 | Diesel Production | US$/KWh generated |   |
| 25 | **Renewable Energy** | **US$/KWh generated** |
| 26 | Solar | Isolated |   | Connected to the Network |   | Hybrid |   |
| 27 | Wind | US$/KWh generated |   | Connected to the Network |   | Hybrid |   |
| 28 | Biomass | Combustion |   | Gasification |   | Other |   |
| 29 | Small Hydroelectric Power Plants | Isolated |   | Connected to the Network |   | Hybrid |   |
| 30 | Biogas | Motors |   | Turbines |   | Others |   |
|   | **GUARANTEES AND SERVICE LIFE INFORMATION** |
| 31 | Diesel Production | Service life (years) |   | Guarantee (Years) |   |
| 32 | Renewable Energy |   |
| 33 | Solar | Service life (years) |   | Isolated |   | Connected to the Network |   | Hybrid |   |
| Guarantee (Years) |   |   |   |   |
| 34 | Wind  | Service life (years) |   | Isolated |   | Connected to the Network |   | Hybrid |   |
| Guarantee (Years) |   |   |   |   |
| 35 | Biomass | Service life (years) |   | Combustion |   | Gasification |   | Other |   |
| Guarantee (Years) |   |   |   |   |
| 36 | Small Hydroelectric Power Plants | Service life (years) |   | Isolated |   | Connected to the Network |   | Hybrid |   |
| Guarantee (Years) |   |   |   |   |
| 37 | Biogas | Service life (years) |   | Motors |   | Turbines |   | Others |   |
| Guarantee (Years) |   |   |   |   |
|   | **INFORMATION ABOUT POTENTIAL PROJECTS IN THE NON-INTERCONNECTED ZONES** |
| 38 | Do you have an interest in developing generation projects in the ZNIs? **(Mark with an X)** | YES |   | NO |   |
| 39 | Under what commercial framework? **(Mark with an X)** | Sale |   | Leasing |   | PPP |   | PPA |   |
| 40 | What are the principal barriers that you have identified to entering in the generation market in the ZNIs **(Rate from 1 to 4, with 4 being the most important)** | Financial |   | Legal |   | Regulatory |   | Others |   |
| 41 | If it is other, please provide a description |   |
| 42 | What are the greatest risks that you identify in this market **(Rate from 1 to 4, with 4 being the most important)** | Financial |   | Contract |   | Payment Source |   | Others |   |
| 43 | If it is others, describe |   |
| 44 | Would you be interested in accessing bank resources to develop Non-Interconnected Zone projects? | YES |   | NO |   |
| 45 | What would be the most important financing condition? (Rate from 1 to 4) | Term |   | Rate |   | Guarantees |   | Other |   |
| 46 | If it is other, please provide a description |   |
| 47 | What is the amount of resources that you would require to finance your projects in the ZNIs? **(Select with an X)** | Up to $1 Billion |   | Between $1 and 5 Billion |   | Between $5 and 10 Billion |   | More than 10B$ |   |
| 48 | **Name of survey respondent** |   |
| 49 | **Telephone** |   |
| 50 | **Email** |   |

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