CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT (CDM-PDD)

PROTOTYPE CARBON FUND

COLOMBIA:
JEPIRACHI WIND POWER PROJECT

September 8, 2003 / April 7, 2004

as amended on November 28, 2003
in response to the draft recommendations of the Methodology Panel
to the CDM Executive Board contained in F-CDM-NMmp ver 03 – NM0024,

as revised on April 7 and 12, 2004
in response to Methodology Panel recommendations as approved by the CDM Executive Board contained in F-CDM-NMmp ver 3 – NM0024

resubmitted for reconsideration by the Methodology Panel and the CDM Executive Board

CONTENTS

A. General description of project activity

A.1 Title of the project activity:

Jepirachi Wind Power Project

A.2. Description of the project activity:

(Please include in the description
- the purpose of the project activity
- the view of the project participants of the contribution of the project activity to sustainable development (max. one page).)

<u>NOTE: Please see the Jepirachi Wind Power Project Baseline Study and Monitoring Plan for more details and background information on all aspects of the project activity.</u>

The project consists of the development of a wind based generation facility with a nominal power capacity rated at 19.5 MW, to be located in Wayuu Indigenous Territory in the Northeastern region of the Atlantic Colombian coast, within the region of Uribia in the Department of Guajira. Once construction is completed in January 2004, the wind generators will be delivering around 68.3 GWh/year to the Colombian National Interconnected System (SIN) under a preferential dispatching scheme.

In accordance with the official indicative expansion plan, options to meet increasing energy demand in Colombia are mostly thermal. Due to the small size of the Jepirachi Wind Power Project (19.5 MW) relative to the net installed capacity (13.2 GW), the proposed project has no effect on the planned expansion of the SIN, but will displace energy that is dispatched at the margin (largely thermal energy).

The Project will contribute to the sustainable development of Colombia in various ways. First, it will demonstrate at a commercial level, the potential for wind based generation in the region thereby facilitating future investments to capture the relatively large aeolic potential (estimated at over 5 GW). Second, it will increase the share of renewable energy in the national grid, thereby contributing to the national private expertise in the installation and operation of such technology. These indirect benefits may stimulate further the development of the renewable option in the Colombian power system. Third, as the project sits in land belonging to a very poor indigenous community, it will contribute to the development of this community through the support of community-driven projects financed by a system of transfers and compensation agreed to by the project sponsor. In this project, the benefits to the host Indigenous Community will be monitored in accordance with a set of indicators as outlined in the Monitoring Plan. Finally, the project will also contribute to an increase in economic activity during the construction period, injecting $21 million in the Colombian economy.

A.3. Project participants:

(Please list Party(ies) and private and/or public entities involved in the project activity and provide contact information in Annex 1.)
(Please indicate at least one of the above as the contact for the CDM project activity.)

- Empresas Públicas de Medellín (EEPPM) , which is one of the biggest utilities in Colombia, is the project sponsor and operator, and will contribute 100% of project financing.

- The Prototype Carbon Fund (PCF). The PCF is a CDM project facility. The International Bank for Reconstruction and Development is the Trustee of the PCF, and purchases Certified Emission reductions on behalf of the Participants in the Fund, comprised of several Annex I Parties and international corporations.

- The Republic of Colombia, through its Ministerio del Medio Ambiente, which is the officially designated national authority, and through the Colombian Energy Planning Unit (UPME) that reports to the Ministry of Mines and Energy.

The PCF is the contact for the CDM project activity.

(Please see Annex 1 for detailed contact information).

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1 Host country Party(ies): Colombia

A.4.1.2 Region/State/Province etc.: Department of Guajira

A.4.1.3 City/Town/Community etc:
Area between Cabo de la Vela and Puerto Bolivar, within the region of Uribia

A.4.1.4 Detail on physical location, including information allowing the unique identification of this project activity *(max one page)*:

The Wayuu Indigenous Territory covers some 10,675 km^2 which was established through Resolution 015/1984 and amended by Resolution 28/1994 to protect the local indigenous population, and represents 51% of a sparsely populated area of the Department of La Guajira, in Colombia. The Project will be located within the Wayuu Indigenous Territory in the Northeastern region of the Atlantic Colombian coast, in the area between Cabo de la Vela and Puerto Bolivar, within the region of Uribia in the Department of Guajira. The topographic characteristics of the area provide the necessary conditions to maximize the power generation potential of the wind farm, that is, the area is not populated, and it is semi-arid with sparse vegetation.

A.4.2. Category(ies) of project activity:

(Using the list of categories of project activities and of registered CDM project activities by category available on the UNFCCC CDM web site, please specify the category(ies) of project activities into which this project activity falls. If no suitable category(ies) of project activities can be identified, please suggest a new category(ies) descriptor and its definition, being guided by relevant information on the UNFCCC CDM web site.)

As of the date of this PDD a list of categories of project activities is not available on the UNFCCC CDM website. The PCF proposes the following for the Jepirachi Wind Power project:

Category: "Mitigation"
Sub-category: "Renewable energy, aeolic capacity addition".

A.4.3. Technology to be employed by the project activity:

(This section should include a description on how environmentally safe and sound technology and know-how to be used is transferred to the host Party, if any.)

The project will contribute to transfer of technology as it will be the first wind power generation facility to operate in Colombia on a commercial basis. All equipment to be utilized in the Project is proven technology that has been successfully applied in similar projects in other regions of the world. Following a bidding process conducted during the summer of 2003, the nominal power capacity of 19.5 MW will be supplied by a total of 15 wind generators with a rated capacity of 1.3 MW each, to be manufactured by Nordex (N60/1300). The Project site will be connected to the national grid via an 8km standard distribution line.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

(Please explain briefly how anthropogenic greenhouse gas (GHG) emission reductions are to be achieved (detail to be provided in section B.) and provide the total estimate of anticipated reductions in tonnes of CO_2 equivalent as determined in section E. below.)

(a) National and sectoral circumstances: Since 1980 the Colombian Electricity Supply System (ESI) has maintained a hydroelectric share in the range 55-75% and a thermal composition in the range 25 to 40%. In 1994, the Government of Colombia enacted legislation to encourage and preserve competition in the energy supply sector that has lead to the gradual liberalization of markets towards free competition. Due to economic conditions, Colombia has witnessed a withdrawal of public sector investments, including in the energy sector, and a greater reliance on the private sector to meet increasing energy demand, which is expected to grow between 3.3 to 4.2 percent annually from 2001 to 2015. Furthermore, after severe droughts registered during the 1990s that caused power shortages with associated forced rationing, the system has encouraged the development of more non-hydroelectric generation capacity, specifically with the intention of increasing the share of firm capacity and enhancing the system's reliability of supply. Taken together, these factors have resulted in a greater share of thermal energy in the SIN, and this trend is expected to continue according to the indicative expansion plan. Given its small size (19.5 MW) relative to the net installed capacity of the SIN (13.2 GW), the Jepirachi Wind Power Project has no effect on the planned expansion of the SIN.

(b) Reductions of emissions: The project employs a non-GHG emitting technology (wind power). In the absence of the Jepirachi Wind Power Project, the same level of demand for electricity would be met by fossil fuel thermal power generation with associated GHG emissions. Generation pricing and merit order dispatch in the Colombian power sector are based on "energy price bidding" by generators for a day ahead based on estimated hourly demand. "Minor plants" (10-20 MW) have the right to participate in the pool and benefit from pool services under a preferential dispatching option (e.g. spinning reserve). In essence, such plants can access the electricity market by selling all their available output at the wholesale market price ("precio de bolsa"), which includes a "capacity payment" component (as a floor price for the bids), and are exempt from penalties on non-delivery of electricity. Since the Jepirachi Wind Power Project qualifies as a minor plant, it will preferentially dispatch its energy in the merit order, and will displace those generating units that are programmed for dispatching according to their bids. Due to their high fuel and operating costs, thermal plants, especially older less efficient ones, are generally dispatched as marginal producers of electricity in the Colombian system. Their output will therefore be partly replaced by the Project activity. The total estimated emission reductions to be achieved by the project is 1.168 Millions tons of CO_2 over 21 years.

(c) Baseline scenario: The baseline scenario is defined as the most likely future scenario. Establishing the most likely future scenario requires an analysis and comparison of possible future scenarios using a baseline methodology that is justifiable and appropriate given the project circumstances. Based on this analysis (see sections B.3. and B.4. below), the baseline scenario consists of the current plants in the Colombian National Interconnected System plus capacity expansion that does not include the proposed project. The Baseline Study shows that least cost fossil fuel thermal power generation options are available to private investors in Colombia at lower kWh costs than the proposed Project activity. The Baseline Study therefore concludes that the Project is an unlikely candidate for system expansion investment. Whether the Project becomes part of the baseline scenario in a more distant future will be checked in accordance with the monitoring plan at the seven year credit period renewal intervals.

(d) Additionality:

In accordance with recent guidance from the Executive Board, several ~~one~~ tools that can be used to demonstrate that a project activity is additional and therefore not the baseline scenario. ~~includes:~~ The Annex 3 (baseline methodology) operationalized these tools and requires that the project meets a combination of two additionality tools out of three as described in the methodology.

The Jepirachi project is additional because it meets the at least the criteria laid out in the methodology annex 3 for the following additionality tools:
- tool (b): cost comparision: Is the project the most economically attractive course of action?
- tool (d): common practice: Is the project not required by law and is less than 5% of power generated using this technology

~~a qualitative or quantitative assessment of different options and an indication of why the non-project option is more likely.~~

To demonstrate project additionality using additionality tool (b), an investment analysis was used to identify the most likely scenario of capacity additions that investors would choose in an effort to maximize profits. Hence, the cost of generating power in the proposed project was compared with the least cost means of alternative investments for generating power in Colombia's interconnected system.

To demonstrate project additionality using additionality tool (d), information was obtained regarding the use of wind energy in Colombia. This information confirmed that nowhere in Colombia wind energy is used for power generation; Jepirachi would in fact be the first wind energy project in the country.

Furthermore, the proposed project faces important barriers, which are listed in Annex 3 under additionality tools (c) and which ~~that in fact~~ further prevent it from being part of the capacity expansion plan.
c.1: ~~First, t~~There is a significant technological barrier as there is no experience in Colombia ~~the country~~ with the implementation of wind-turbine technology to generate electricity on a commercial basis; i.e. no domestic company employs this technology.
c.2: ~~Secondly, t~~There are significant investment barriers, as local developers have no access to equity and debt in the local and international markets, largely due to the high risk of investments in Colombia.
c.3: ~~Thirdly, t~~The expansion planning in Colombia calls for an increase in the thermal generation, given the high reliance on hydroelectric capacity, in order to provide a more secure supply of energy. Wind energy is not an appropriate choice to meet this objective as it is unreliable and uncertain. This is confirmed by the fact that all capacity expansion since the liberalization of the energy sector in 1995 has been in thermal energy.

Hence, the project is additional because it will generate emission reductions that would not occur otherwise, since the project does not present an economically attractive investment opportunity and is not common practice in Colombia. Additionality, ~~G~~given the significant technological and investment barriers associated with wind energy in the country, the project sponsor is unlikely to invest in the project in the absence of carbon finance.

A.4.5. Public funding of the project activity:

(In case public funding from Parties included in Annex I is involved, please provide in Annex 2 information on sources of public funding for the project activity, including an affirmation that such funding does not result in a diversion of official development assistance and is separate from and is not counted towards the financial obligations of those Parties.)

This project will not be funded by international Official Development Assistance (ODA) or other sources earmarked for development assistance.

B. Baseline methodology

B.1 Title and reference of the methodology applied to the project activity:

(Please refer to the UNFCCC CDM web site for the title and reference list as well as the details of approved methodologies. If a new baseline methodology is proposed, please fill out Annex 3. Please note that the table "Baseline data" contained in Annex 5 is to be prepared parallel to completing the remainder of this section.)

There is no methodology choice available on the UNFCCC website yet. According to the modalities and procedures of the CDM, project participants should select the baseline approach that is most relevant for the proposed project.

The baseline approach adopted for this project is option 48(b) of the Marrakech text: "The baseline is the scenario that represents emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment".

Approach 48 (b) cannot readily be applied as a baseline methodology and must be interpreted and made operational in view of the project circumstances. The approach is based on the notion that the selection of the most likely future scenario is determined by economically rational behavior. Therefore, an investment analysis appears to be an appropriate interpretation of the approach.

Annex 3 of this PDD proposes a baseline methodology that concretizes the idea of an investment analysis for power sector projects and proposes the following name for this methodology:

<u>"Least cost analysis and optimization modeling for renewable energy capacity additions to existing power systems"</u>

An explanation of this new methodology, the condition under which it can be applied and the steps to follow are provided in Annex 3. A justification of the methodology's appropriateness, given the project circumstances, is provided below.

B.2. Justification of the choice of the methodology and why it is applicable to the project activity

Baseline approach 48 (b) refers to the baseline scenario as "an economically attractive course of action". This appears to be an appropriate, and therefore justified, approach for investment projects for the following reasons:

The proposed Project involves a significant private sector investment in power generation capacity expansion. This investment must earn returns in competition with other power generation options, notably fossil fuel based thermal capacity additions. It therefore appears appropriate to assume that the decision between alternative capacity investments is made on the basis of an investment calculus that determines the economically most attractive course of action.

A "least cost analysis of power capacity expansion ", as described in Annex 3, appears to be an appropriate baseline methodology for the following reasons:

(a) A least cost analysis is usually the method of choice in national power planning, because it minimizes the overall economic costs of satisfying the national demand for power.
(b) The private sector invests in power capacity expansion for maximum return on investment.
(c) Everything else being equal, projects and technologies with the lowest costs per unit of electricity output (kWh) are likely to yield the highest returns.

It therefore appears justified to use capacity expansion costs (costs per kWh) as indicator and identify the baseline scenario as the existing system plus the least costs capacity expansion, this being an economically attractive course of action.

B.3. Description of how the methodology is applied in the context of the project activity:

The methodology in Annex 3 is applied here in the following way. First, it was confirmed that all necessary conditions for the use of the methodology are fulfilled:

- The proposed project is a relatively small (under 50MW) renewable energy capacity addition to an existing grid. As a wind farm with a capacity factor of ca. 40%, the project does not deliver reliable electricity that could be counted as firm energy in the Columbina System.
- The geographic and system boundaries of Colombia's interconnected system can be clearly identified.
- Sufficient information on the characteristics of the system and selected variables is available (see No. B.5).
- The Colombian power sector does not feature centralized expansion planning, but an open market in which private power producers compete on the basis of cost.
- The Colombian authorities are experienced in the use of the power system optimization model SUPER/OLADE-BID and have used it to support the development of the baseline for this CDM project.
- The project does not result in any significant leakage and therefore no methodology to calculate and take leakage into account is needed.

(A) Project additionality test based on the additionality tools

Then, following the methodology in Annex 3, a project additionality test involving a cost comparison and a common practice test was undertaken. The test shows that the project is more expensive than power generation alternatives and that wind energy is not common practice in Colombia. Thus, as per the described methodology, it is demonstrated that the project is additional.

Additionality tool (b): cost comparison

Is the project the economically most attractive course of action?
Cost comparison

The methodology then applied a cost comparison to the project following the steps prescribed for the methodology as outlined in Annex 3. Further details are contained in the baseline study, which is attached as background information to this PDD.

1. The geographic and system boundaries for the application of the methodology were determined. They are described in B.5 below as the boundaries of the country and its interconnected system.
2. Alternative capacity expansion were identified that can help meet Colombia's electricity demand at competitive prices. The potential candidates for capacity expansions are mostly thermal options: coal based steam power plants, gas based combined cycle plants (CCGT) and gas based open cycle turbines (OCGT), in addition to hydropower[1].
3. The total net generation cost per MW for various plausible alternatives was conservatively calculated using the following EPRI TAG formula:

$$Cost\ per\ kWh = \frac{(Investment * CRF) + O\&M\ Costs}{Generation} \left[\frac{US\$}{kWh}\right]$$

where:

Investment: Total investment cost of the project (in US$)

O&M Cost: Operation and maintenance costs (in US$)

Generation: Electricity supplied by the project (in kWh)

Capital Recovery Factor (CRF): $\frac{r}{1-(1+r)^{-n}}$

Where $r = 10\%$
$n = 20$ years

In order to determine the net generation costs per MW of each technological alternatives available to Colombia, the Colombian Energy Planning Unit (UPME) assessed the investment costs and operational and maintenance costs through an in-depth analysis that involved both market research and consideration of local conditions through interviews with power producers. Wherever necessary, national studies were used to determine future projected prices, for example for natural gas, which was conducted by a special

[1] The baseline study examines several plausible low cost system expansion options that private investors would choose on the basis of demand projections, spot market prices, investment costs and expected prices of fuels.

unit that monitors and model the natural gas market. The information is then used in an optimization model to determine the reference expansion plan, which identifies capacity addition to the grid based on least cost.

In accordance with this method, the cost of the various alternatives are as follows:

- US$ 32.8 / MWh for a mid-sized combined cycle gas turbine (150 MW) ,
- US$ 36.5 / MWh for a mid-sized open cycle gas turbine (150 MW), and
- US$ 35.3 / MWh for a mid-size coal-based steam power plant (150 MW).

The total net generation cost for the proposed Project was conservatively calculated at US$ 38.35 / MWh using the same calculation method. (See the baseline study and PDD Annex 5 for details of the cost calculations.) Hydropower plants were not considered a plausible scenario given limited site availability and its effect on cost, high up-front capital required, and environmental and social aspects associated with reservoirs.

The cost analysis shows that the Project is not a least cost expansion option. The scenario without the proposed Project is therefore economically more attractive than the alternative scenario with the project. This makes the former the most likely baseline scenario.

Additionality tool (d): Common practice test

d.1: *Is the project technology not required by the host country's legislation or regulation?*

There is no law or regulation in Colombia that would require the use of wind power or this implementation of the Jepirachi project.

d.2: *Will the project use a technology, or an energy resource (fuel), that currently contributes, or within 3 years is expected to contribute, less than 5% of the total generation (GWh) coming from at least 5 power plants in the host country?*

The project is the first wind energy project in Colombia. The technology thus contributes less than 5% to overall power generation and it is not expected that this would change in the near future (i.e. within 3 years).

(B) System expansion model, and
(C) Determination of the project's impact on system operation and expansion

The baseline scenario, as determined above, is the interconnected power system in Colombia and its expansion, development and operation (including im- and exports) over time, but excluding the proposed Project (and other future CDM projects). This baseline scenario was confirmed through the use of a optimization model (SUPER/OLADE-BID), which indicates that when taking into account plants under construction, cost information provided by the major generators, demand projections, fuel prices and other conditions, the capacity expansion for the interconnected power system in Colombia will be provided by thermal options beyond 2002, and not by the proposed project. Furthermore, the system currently relies on fossil fuel fired thermal plants (coal and gas-based power plants) to satisfy peak load demand and for general power dispatch at the margin.

Give this result and the fact that the project involves a wind-farm the capacity of which is not firm and therefore needs backup capacity (Section B.4), it is concluded that the project does not postpone the construction of new capacity and will only replace the operation of alternative generation units in the Colombian grid.

(D) Projection of emission reductions using a dispatch model

The expected reductions were calculated using the SUPER-OLADE/BID dispatch model component. The underlying assumptions and the modeling results are reported in Section B.4 and E.6.

Time dimension of the baseline

The current operational characteristics are expected to continue for the foreseeable future (at least for the first 7-year crediting period) with or without the proposed Project. It is likely that, in the baseline scenario as well as in the absence of further CDM project, additional thermal base load capacity will be added to the system in this decade. The difference in generation costs between the Project and the low cost alternative of ca. US$ 5.5 per MWh (ca. 16 %) is large enough to make it unreasonable to anticipate that the Project would become a least cost expansion option for at least the first 7-year crediting period and would then be part of the baseline scenario.

B.4. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity ***(i.e. explanation of how and why this project is additional and therefore not the baseline scenario)***

The determination of the baseline scenario is explained in the steps above through the application of the baseline method. The project is additional, because it would unlikely occur without CDM assistance and because it reduces emissions relative to the projected emission level in the baseline scenario.

Since the project will significantly reduce the reliance of Colombia on fossil fuels for power generation and is not associated with any significant leakage, it will reduce emissions as compared with the baseline scenario (determined above). The implementation of the Project will therefore result in emission reductions. A projection of baseline emissions and emission reductions is contained in the attached baseline study and reported in Section E of this PDD.

Furthermore, a quantitative and qualitative assessment demonstrates that the Project is not part of the baseline, since lower cost alternatives are available in the country, and since there are significant technological and investment barriers to the implementation of wind technology in Colombia. These barriers are outlined in Section A4.4 above.

In addition, the UPME team used the expansion model to test whether the construction of the project would have any impact on the addition of alternative capacity by forcing the project into model runs. This test showed that, due to its size and characteristic as non-firm energy, the Project does not delay the addition of other capacity to the system or hasten the retirement of older plants. Thus, its impact on emissions results exclusively from adjustments in the operation of existing plants.

The UPME team has finally used the dispatch module in SUPER/OLADE-BID to prepare a projection of emission reductions to which the Project gives rise. The UPME team ran the dispatch module without the Project to simulate the baseline scenario and with the Project to simulate the Project scenario and then calculated the emissions difference between the two scenarios, which represents the projected emission reductions. This modeling approach simulates the *ex post* monitoring and calculation method that the Project proposes to determine real and additional emission reductions accurately.

B.5. Description of how the definition of the project boundary related to the baseline methodology is applied to the project activity*:*

The boundary that is relevant for the application of the baseline methodology defines where alternatives to the proposed project are likely to be found. The baseline methodology determines the baseline scenario for the Project within the following boundaries:

- *Geographic boundary*: Power projects that feed into the national grid can be established almost anywhere in the country, but not outside of Colombia, because to date no significant transmission capacities and related institutions between Colombia and its neighbors exist. The geographic boundaries are therefore Colombia's international borders.
- *System boundary*: Colombia has an interconnected power system, which covers most of the country. Colombia is also small enough so that the Project may have an effect on power generated anywhere else in Colombia. The system boundaries are therefore the Colombian interconnected system.
- *Time boundary*: The planning and construction of new power plants involves multi-year projections. The baseline methodology therefore permits to determine a valid baseline scenario for a number of years, beginning with the time of the Project's preparation. With appropriate provisions for monitoring of relevant developments in the baseline scenario – as provided for in the monitoring plan for this Project – the time boundary, and thus the validity of the baseline scenario, extends to the end of the 21 year crediting period.

B.6. Details of baseline development

B.6.1 Date of completing the final draft of this baseline section *(DD/MM/YYYY)*:

31/08/2003

B.6.2 Name of person/entity determining the baseline:

(Please provide contact information and indicate if the person/entity is also a project participant listed in Annex 1.)

1. Charles Cormier/ Sandra Greiner /Johannes Heister, Prototype Carbon Fund, c/o World Bank, 1818 H Street, NW, Washington D.C., 20433, USA, Tel: +1-202-4730836; Fax: +-202-473 0836; sgreiner@worldbank.org; jheister@worldbank.org; ccormier@worldbank.org
2. Walter Vergara/ Gabriela Elizondo Azuela, Latin America Environment Department, World Bank, 1818 H Street NW, Washington DC 20433 (wvergara@worldbank.org. gazuela@worldbank.org). The World Bank conducted due diligence on the project.
3. Mr. Ismael Concha, Energy and Mines Planning Unit, Colombian Ministry of Mines and Energy, Avenida 40A No. 13-039 Piso 5, Santa Fe de Bogota, Colombia (upme1@inter.net.co)

C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

(For a definition by the Executive Board of the term "starting date", please refer to UNFCCC CDM web site. Any such guidance shall be incorporated in subsequent versions of the CDM-PDD. Pending guidance, please indicate how the" starting date" has been defined and applied in the context of this project activity.)

The project is expected to start operating and generating emission reductions in January 2004.

C.1.2. Expected operational lifetime of the project activity: *(in years and months, e.g. two years and four months would be shown as: 2y-4m)*

21 years: The operational lifetime of the project is estimated as 21 years, as is common for wind power plants.

C.2 Choice of the crediting period and related information

(Please underline the appropriate option (C.2.1 or C.2.2.) and fill accordingly)
(Note that the crediting period may only start after the date of registration of the proposed activity as a CDM project activity. In exceptional cases, the starting date of the crediting period can be prior to the date of registration of the project activity as provided for in paras. 12 and 13 of decision 17/CP.7 and through any guidance by the Executive Board, available on the UNFCCC CDM web site)

C.2.1. Renewable crediting period *(at most seven (7) years per period)*

C.2.1.1. Starting date of the first crediting period (DD/MM/YYYY):

The first crediting period will start with the generation and monitoring of the first emission reductions. The expected start date is: 1 January 2004.

C.2.1.2. Length of the first crediting period *(in years and months, e.g. two years and four months would be shown as: 2y-4m)*:

7 years.

C.2.2. Fixed crediting period (*at most ten (10) years*):

C.2.2.1. Starting date (DD/MM/YYYY):

C.2.2.2. Length (max 10 years): (in years and months, e.g. two *years and four months would be shown as: 2y-4m)*

D. Monitoring methodology and plan

(The monitoring plan needs to provide detailed information related to the collection and archiving of all relevant data needed to
- estimate or measure emissions occurring within the project boundary;
- determine the baseline; and;
- identify increased emissions outside the project boundary.
The monitoring plan should reflect good monitoring practice appropriate to the type of project activity. Project participants shall implement the registered monitoring plan and provide data, in accordance with the plan, through their monitoring report.
Operational entities will verify that the monitoring methodology and plan have been implemented correctly and check the information in accordance with the provisions on verification. This section shall provide a detailed description of the monitoring plan, including an identification of the data and its quality with regard to accuracy, comparability, completeness and validity, taking into consideration any guidance contained in the methodology.
Please note that data monitored and required for verification and issuance are to be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.)

D.1. Name and reference of approved methodology applied to the project activity:

(Please refer to the UNFCCC CDM web site for the name and reference as well as details of approved methodologies. If a new methodology is proposed, please fill out Annex 4.)
(If a national or international monitoring standard has to be applied to monitor certain aspects of the project activity, please identify this standard and provide a reference to the source where a detailed description of the standard can be found.)

The project uses the following monitoring methodology:

"*Ex post* dispatch analysis for renewable power projects in integrated electric systems"

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The Project generates emission reductions by displacing power that would otherwise have been produced and dispatched by other plants in the Colombian National Interconnected System. As a "minor" plant (more than 10 MW but less than 20 MW), the Jepirachi Wind Power Project will access the electricity market through a preferential dispatch system on an equal footing with thermal and hydropower, by selling all their available output at the wholesale market price. Whenever the Project is dispatched, it moves other power plants that are programmed for dispatching according to their bids up in the dispatch order and thus eliminates power generation that would otherwise have been dispatched from one or two plants at the operating margin. Conversely, when there is no wind available, sources of energy other than that being generated by the Jepirachi Wind Power Project will have to be dispatched, which is not a priori known.

The Colombian power sector is organized by the wholesale market which establishes clear criteria for merit order of dispatch, and thus of delivery into the grid. Since the Jepirachi Wind Power Plant benefits from a preferential dispatch system, it will have no impact on the bidding behaviour of other dispatchable power plants. Under these conditions, the marginal dispatch methodology is an accurate *ex post* measurement of emission reductions. As opposed to other methodologies based on counterfactual scenarios, the dispatch methodology uses real data from actual operating projects, thus being a credible and verifiable methodology that assures the environmental integrity of the Project. The dispatch methodology most closely mirrors the actual operation of the market, thus removing speculation of "what would have happened" and increasing transparency.

The above monitoring methodology is chosen, because it matches most closely the changes that will occur in the Colombian National Interconnected System due to the implementation and operation of the Project. More specifically, the use of this methodology which calculates emission reductions *ex post* is appropriate and justifiable because:

- the methodology results in an accurate yet directly observed calculation of emission reductions,
- the project is of the type for which this methodology was developed, and
- the project and system circumstances meet the conditions set our for the application of the methodology.

The conditions for use of the methodology are met in the following ways:

1. The methodology builds on the identified characteristics of the baseline scenario and instructs to monitor all aspects of the baseline that are relevant to determine baseline emissions and which are not already determined in the formulation of the baseline scenario. The monitoring methodology therefore ties seamlessly in with the baseline methodology and the formulation of the baseline scenario.
2. The project is a relatively small addition to the Colombian electricity system. As a hydropower project with low operating costs, it will be preferentially dispatched in the base or medium load curve before fossil fuel plants with higher operating costs are dispatched. As was shown, due to its characteristics, the project will not have an impact on capacity additions but will most likely replace power that would otherwise be dispatched by plants that operate at the dispatch margin.
3. Since the project will make use of preferential dispatch and will not participate in the spot market through bidding, its participation in the market does not give rise to strategic bidding or change in other ways the bidding behavior of other market participants. The dispatch order that results from such bidding is thus representative of the dispatch order that would occur in the absence of the project.
4. The future of the Colombian electricity system being uncertain, *ex post* monitoring and calculation of emission reductions is justified, because it promises to significantly increase the accuracy of the baseline emission projections and the calculation of the emission reductions.
5. Finally, the project operator expects that he will be able to monitor and/or obtain the necessary data on system operation and dispatch that required by the methodology. And there is no reason to expect that this data will become unavailable in the foreseeable future.

The project operator will calculate actual emission reductions of the Project by monitoring the hourly system operations and observing the actual power station running at the margin, which is assumed to be displaced by the Project. The monitoring methodology measures the impact of the Project on power provision in Colombia by identifying the marginal producers using systematically collected dispatch data and the Project's electricity output. The project operator may develop and propose a sampling methodology for monitoring, if he shows that the proposed sampling yields equally accurate result.

The concept for the calculation of emission reductions and the monitoring instructions for the project are explained and implemented in Annex 4 and in the attached Monitoring Plan. The data needed to calculate emission reductions will be recorded in the Project's electronic workbooks.

Project boundary related to monitoring of emission reductions:

Geographic boundaries: The project's geographic boundaries comprise the Project site and any installations required to transfer the project's power to the grid.
System boundaries: The system boundaries comprise the existing electricity generation and National Interconnected System in Colombia, including im- and exports, and the corresponding expansion of the System.
Time boundaries: Monitoring will begin with the first regular dispatch of the Project's power to the Colombian grid and is expected to continue through the planned 21 year crediting period.

D.3. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

Being a wind power project, no emissions from the project activity were identified. The table is therefore left uncompleted.

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recordin g frequenc y	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
1	Electricity generation of the Project	J	MWh	m	Hourly	100%	Electronic and paper	Crediting period plus 3 years	

D.4. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources.

Such emissions can result from project construction, transportation of materials and fuel and other up-stream activities. In the case of the proposed Project, these emissions are thought to be negligible, because similar or higher life cycle emissions would result from the eventual construction and operation of alternative capacity. The life cycle emissions of alternative power generation plants, in particular of fossil fuel power plants, are typically higher than from wind power plants when including emissions due to the mining, refining and transportation of fossil fuel. The Project does not claim emission reductions from these activities. Therefore, no significant net leakage from the above activities was identified.

No such sources of emissions were identified, and therefore no data will be collected and archived (see summary discussion below). The table can therefore not be filled. Please refer to Sections B.5. and E.2 and to the Baseline Study and Monitoring Plan for more information.

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
	No relevant leakage identified								

D.5. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHG within the project boundary and identification if and how such data will be collected and archived.

The following data is used to determine the baseline of emissions within the project boundaries. Please note that the methodology does not require to determine all system emissions, but only those that are affected by the project The names of the data variables (column three) are those of the Monitoring Plan and the associated spreadsheets.

(Depending on the methodology used to determine the baseline this table may need to be filled. Please add rows to the table below, as needed.)

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain)	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
1	Capacity of each plant in the NIS	C_i (C_M, C_N, …)	MW	Y	Electronic and paper	Crediting period plus 3 years	UPME report
2	Dispatch of electricity from each power plant in the NIS	E_i (E_M, E_N …)	MWh	Y	Electronic and paper	Crediting period plus 3 years	CND report

3	Dispatch order based on economic merit order for each power plant in the NIS	-	Name of marginal plant and rank in dispatch order	Y	Electronic and paper	Crediting period plus 3 years	CND report
4	Actual efficiency of likely marginal plants	E_i	% or TJ/GWh	Y	Electronic and paper	Crediting period plus 3 years	UPME report, if available, or manufacturer data or IPCC default values
5	Actual emission factors of likely marginal plants	EF_i	tCO2e/ MWh	Y	Electronic and paper	Crediting period plus 3 years	Calculated using *Ei* and IPCC data for calorific values and carbon emissions of fuels.

Note: Data available from the Colombian Energy Planning Unit (UPME) that reports to the Ministry of Mines and Energy.

Note: Under the Colombian National Interconnected System (or NIS), the Centro Nacional de Despacho (CND) is responsible for programming and carrying out the NIS dispatch. The CND programs the dispatch of generators by strict economic order, considering the need to supply demand and the operational costs of the all units available for dispatch. The outcome is the hourly generation program for each power unit and the hourly marginal cost for the NIS (the cost of producing an additional kWh of energy in the system equals the highest operational cost of units in operations at a particular time). On the basis of daily scheduling, the CND then coordinates in real time the dispatch of power units. The CND prepares daily and monthly reports of the actual operation of the NIS, including in those reports the hourly generation for each power unit and the marginal cost for each hour. The information required for ex post determination of the baseline is thus made available by CDN to all market agents, including the Project developer, and a summary is available publicly through the CND website.

D.6. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored.

(data items in tables contained in section D.3., D.4. and D.5 above, as applicable)

All monitored and collected data is subject to auditing and verification.

Data *(Indicate table and ID number e.g. D.4-1; D.4-2.)*	Data type	Uncertainty level of data (High / Medium / Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
D.4.-1.	Electric output	Low	Yes	To ensure accuracy, electronic commercial metering will be placed at the generation bus. The metering system will comply with technical specifications issued by the CND for commercial metering. This technical specification details the precision of metering transformers and meters, and all the parameters to be metered and recorded, as well as the frequency with which they should be recorded.
D.5.-1	Capacity of plants	Low	Unknown	Data is received from UPME.
D.5.-2	Dispatched electricity	Low	Unknown	For every hour of the monitoring period, the actual dispatch of the NIS is communicated daily to all operators by CND electronically .
D.5.-3	Plant names and dispatch order	Low	Unknown	Every day, the CND produces a list of weekly dispatch order of power generation facilities (priority list) based on economic merit order. The list is made available to all operators electronically.
D.5.-4	Actual plant efficiencies	Low	Unknown	Annually reported by UPME, or manufacturer or IPCC data.
D.5.-5	Actual plant emission factors	Low	Yes	The project operator will calculate the CIFs of each plant in CND's Dispatch Priority List using reference values for types of plants provided by the Intergovernmental Panel on Climate Change (IPCC) Technology Inventory and reported in the Monitoring Plan. The CIFs are to be recalculated / verified by an Operational Entity.
~~D.5.-7~~	~~Generation cost for the Project~~	~~Low~~	~~No~~	~~Reported in Monitoring Plan (based on IPCC) and (to be) validated.~~
~~D.5.-9~~	~~Cost of alternative low cost power~~	~~Low~~	~~No~~	~~Reported in Monitoring Plan and (to be) validated / verified.~~

D.7 Name of person / entity determining the monitoring methodology:

(Please provide contact information and indicate if the person/entity is also a project participant listed in Annex 1 of this document.)

1- Charles Cormier/ Sandra Greiner /Johannes Heister, Prototype Carbon Fund, c/o World Bank, 1818 H Street, NW, Washington D.C., 20433, USA, Tel: +1-202-4730836; Fax: +-202-473 0836; sgreiner@worldbank.org; jheister@worldbank.org; ccormier@worldbank.org

2. Walter Vergara/ Gabriela Elizondo Azuela, Latin America Environment Department, World Bank, 1818 H Street NW, Washington DC 20433 (wvergara@worldbank.org. gazuela@worldbank.org). The World Bank conducted due diligence on the project.

E. Calculation of GHG emissions by sources

E.1 Description of formulae used to estimate anthropogenic emissions by sources of greenhouse gases of the project activity within the project boundary: *(for each gas, source, formulae/algorithm, emissions in units of CO_2 equivalent)*

Zero

The project is a wind power project; it does not give rise to direct GHG emissions. Therefore, no formula is provided here.

E.2 Description of formulae used to estimate leakage, defined as: the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and that is measurable and attributable to the project activity: *(for each gas, source, formulae/algorithm, emissions in units of CO_2 equivalent)*

Leakage is defined as the net change of anthropogenic emissions by sources of greenhouse gases that occurs outside the project boundary, which can be measured and directly attributed to the CDM project activity.

No leakages were identified. Therefore, no formula is provided here.

E.3 The sum of E.1 and E.2 representing the project activity emissions:

Zero.

E.4 Description of formulae used to estimate the anthropogenic emissions by sources of greenhouse gases of the baseline: *(for each gas, source, formulae/algorithm, emissions in units of CO_2 equivalent)*

~~Not applicable, because the project directly monitors and calculates the ERs~~

The ex post evaluation of the avoided emissions does not facilitate the explicit determination of the emissions in the baseline scenario~~emissions~~(i.e. the power system), however, within the methodology, the relevant emissions from the baseline scenario (those being replaced) are calculated hourly as follows:

Baseline emissions (T CO2e) = Carbon emissions factor for the marginal plant(s) (tonnes CO2e per kWh) * kWh generated by Jepirachi (kWh)

The emission factor for the marginal plant is obtained from or calculated based on data obtained from the national dispatch center. The marginal plant is determined by identifying the power source (plant and capacity) that would be called upon to generate and dispatch power, if the project failed to operate (e.g. lack of wind). The system's merit order and actual dispatch information is obtained from the dispatch center. The marginal plant for each hour is the plant (or plants) that has (have) free capacity and would be called upon to dispatch if Jepirachi went off line for this hour; the plant (plants) to be called are those next in line in the merit order. A description of how the merit order is generated by the dispatch center is attached.

E.5 Difference between E.4 and E.3 representing the emission reductions of the project activity:

The monitoring plan provides for the calculation of emission reductions from displaced grid electricity. The calculation formulae are contained both explicit and programmed in the attached self-calculating Excel spreadsheets. The calculations are done in the following way (please refer to the monitoring plan and the spreadsheets for details):

Baseline emissions are calculated by the following formula:

Sum over all hours of:
The project's hourly electricity dispatched to the grid
X
The emission factors of the identified marginal thermal plants

The outline of the method to calculate emission reductions is as follows:

Hourly net generation output from the project (MWh)

⇩

Determination of additional thermal energy that would have been dispatched if the project were not generating

⇩

Determination of Emission Factor(s) (EF)
for the involved marginal plant(s) (tCO_2 /MWh)

⇩

Calculation of hourly emission reductions generated by the project (tCO_2)

⇩

Calculation of net daily, monthly, and annual CO_2 emissions avoided by integration of hourly data (tCO_2)

The following table shows the calculations: The incremental generation is the capacity that the marginal plant and, if necessary, the next marginal plant in line can contribute, if the project were not generating. The incremental generation is calculated as the residual capacity.

The following table calculates hourly emission reductions, which the project operator sums up to produce and report the numbers for daily, weekly and monthly emission reductions. The notation is as follows:

G_J:	Generation of project *J*
EF_M:	Emission Factor for the marginal plant *M*
C_M:	Capacity of the marginal plant *M*
E_M:	Generation of the marginal plant *M*
EF_N, C_N, E_N:	Equivalent for the next marginal plant *N* (and so forth)

		B	C	D
	Calculation of ERs	**Every Hour**		
			EF_i (CO2t/MWh)	**ER_J (CO2t)**
1	**Jepirachi**	G_J		
2	**Marginal Plant**		EF_M	
3	Capacity (MW)	C_M		
4	Generation (MWh)	E_M		
5	Incremental Generation (MWh)	if $(C_M - E_M) >= G_J$, then $= G_J$ else $C_M - E_M$		=B5*C2
6	**Next in Line Marginal Plant**		EF_N	
7	Capacity (MW)	C_N		
8	Generation (MWh)	E_N		
9	Incremental Generation (MWh)	if $(C_M - E_M) <= G_J$, then $G_J - (C_M - E_M)$ else = 0		=B9*C6
	Total Hourly ER			=D5+D9

NOTE: As calculations are done in MWh and Capacity expressed in MW, numbers coincide

E.6 Table providing values obtained when applying formulae above:

Due to the nature of the ER monitoring and calculation process most appropriate for this category of project, the above formula cannot be directly used to complete the table below.

In order to estimate the emission reductions that will result from the implementation of the proposed project, emissions of the expansion plan with and without the proposed projects were compared using an optimisation model (SUPER/OLADE-BID), as described in the baseline study.

The projection of ERs relies on the following assumptions about the future system configuration and dispatch of electric power in the Colombian National Interconnected System (NIS). These assumptions are not guaranteed by the baseline study or the monitoring plan; the future operation of the NIS, which will be monitored to calculate ERs, may turn out to be significantly different.

- Due to the investment and sector conditions, no large-scale thermal or hydroelectric projects are expected to be implemented in Colombia in the foreseeable future. Hydroelectric resources are expensive due to less than favorable geological conditions and are not likely to attract private investors.
- The rapid growth in demand and the scarcity of new projects practically ensure that all existing generation capacity must be kept in service for the foreseeable future.
- Existing thermal units in the NIS include a large number of plants of various sizes, and some of these are very old, with low efficiencies. These plants are likely to continue in operation for the foreseeable future.
- Any new plants that can be implemented must compete with existing generation. As new plants will be more efficient than most of the existing plants, they will operate either as base-load or in the medium range.
- It can therefore be assumed that the Project will displace energy from the less efficient group of plants. These older plants employ various technologies, use different fuels, and have different efficiencies. They also have different useful lives remaining.

Based on the above assumptions regarding NIS expansion and operation and taking the annual average generation of Jepirachi (68.3 GWh/y) and the average of CIF values of plants assumed to be displaced by the Project's generation, the CO2 emissions avoided by the project are estimated by the optimization model to be 1.168 Mt/CO2 during the lifetime of the project (21 year crediting period).

The following table shows the projected project emissions, leakage, baseline emissions and emission reductions per annum and for the crediting period.

	Emissions (tCO2)
Project emissions (E.1)	0
Leakage (E.2)	0
Sum (E.3)	0
Emission reductions for 7 years	264,954
Emission reductions for 14 years	632,964
Emission reductions for 21 years	1,168,000

F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts

(Please attach the documentation to the CDM-PDD.)

Empresas Publicas de Medellin carried out an environmental impact assessment (EIA) including physical, biological, socioeconomic and cultural components. Local communities were consulted throughout the EIA process. The EIA includes detailed mitigation and contingency plans and an outstanding consultation process with local communities. A summary of the findings follows (excerpted from the World Bank Project Appraisal Document):

Summary of Findings of Environmental Impact Assessment
Excerpt from Annex 13 of Project Appraisal Document

This document briefly summarizes the findings of the Environmental Impact Assessment for the Jepirachi Wind Power Project.

Main Potential Environmental Impacts Associated with Wind Power Plants

Environmental (physical and ecological) issues related to wind power projects that could be of concern include:

- The resulting impacts from the construction of power transmission lines;
- The opening of new access roads, which can lead to indirect impacts around the project area;
- Increase in noise pollution, depending on the number and model of the turbines and the distance between them, as well as the location of the power plant in relation to existing housing;
- The rotating arms can kill birds, and the negative impact can be especially serious if the windmills are located in the path of migratory birds;
- Impacts on native vegetation and archeological sites as a result of construction activities for windmill towers, transformers, and access roads; and
- Impacts on the scenic value of the area since wind-power plants are usually located at the top of hills or in open land, both of which make them visible from far away.

Power Transmission Lines

No significant environmental issues related to power lines have been identified. Both the wind farm and the grid connection will be located at least 200 m apart from the coast so as to minimize impacts on birds and their routes. Some collisions of non-marine birds may occur with the wind turbines, but these will be minimized by strategically locating the anchors, the towers and providing a light color to the installations.

Road Construction and Improvement

The Jepirachi Wind Power Project will not include new road construction or major road improvements through natural forests, wetlands, protected areas, or other ecologically sensitive areas. The project site has been chosen so as to minimize the demand for infrastructure access during construction, installation and operation of the project. Impacts during construction works for temporal and no-temporal access roads will not be significant given the topography and other physical characteristics of the project site (e.g. semi desert ecosystem with almost no vegetative cover and no organic content, rain volume is minimal, etc.). From the geo-technical point of view, only a superficial preparation will be needed for cleaning and access leveling works. The EIA indicates that aggregate material would be extracted from the edges of the Apure and Paat Arroyos, and clarify that no material will be extracted from wet stream-beds.

Noise

New wind technology is significantly less noisy than older technologies. In particular the slow moving blades selected for this unit will reduce noise impacts. In addition, the site is 1.5 km away from the nearest settlement, further masking the noise as part of the background noise prevalent in the area (wind gusts).

Other Complementary Facilities: The EIA has identified the impacts that might be derived from construction activities and has included a program for the prevention and mitigation of these impacts within the Environmental Management Plan. In particular, this program will ensure that contractors follow good construction and environmental practices. As part of the social program, small facilities and civil works will be undertaken, namely refurbishing of school facility, health center, small water storage pits, the set up of 2-4 m3/hour desalinization plant and refurbishing of the cemetery. Same procedures will be followed even though the impacts anticipated are negligible.

Compliance with Natural Habitats (OP4.04): The EIA clarifies that the project will have minimum impact on the natural environment of the area. The project will not be located within existing or officially proposed protected areas. The project's impact on local biodiversity will mostly be negligible because relatively so little land will be cleared (and, in the case of bird collisions, project design seeks to minimize any adverse impacts). The anticipated, relatively minor impacts on natural habitats and biodiversity are of three types:

(a) Land clearing: the land to be cleared to install the wind turbines is6.5 km2400 m access road, borrow pits, and complementary facilities that totals only 7 ha, of which only 6 ha would remain cleared permanently. The area of the vegetation to be affected by the project is a very tiny fraction of the remaining total of this ecosystem type on the Guajira Peninsula, so the loss is not at all significant.

(b) Construction worker behavior: To minimize any incidental harm to wildlife during project construction, the Environmental Management Plan specifies that all contractors and construction workers will be prohibited from (i) any hunting, killing or capture of wild animals or herds used by the Wayuu (ii) any cutting, burning or collection of natural vegetation (including cacti) that is not strictly required for project implementation and approved by the supervising engineer in the field and (iii) contamination of waterways with solid or liquid wastes.

(c) Potential bird mortality: From a natural habitats degradation and biodiversity conservation standpoint, the project's potentially most serious adverse impact could be bird mortality from wind turbine collisions, or transmission line collisions or electrocutions. These impacts are expected not to be significant due to the following project siting and design features: (i) the siting of the windmills will not overlap with normal flight paths of birds found in the area (ii) the wind turbines have a bird-friendly design, with large slow-moving blades, tubular towers (with no attractive bird perches near the blades) that include a plastic device at the top of each one and with a visible color clearly identified by flying birds (iii) the distance between the transmission line conducting wires will be at least 2.5 m apart to avoid electrocuting any birds of prey (iv) the top power line will be made more visible to flying birds with inexpensive plastic devices.

Cumulative Effects: The project will not increase the environmental load in the area in any significant manner.

Social Aspects: In order to ensure close linkage and harmonization of project activities with the indigenous peoples of the area as well as to ensure respect and integrity of their culture, Empresas Publicas de Medellin designed and implemented a Social Management Plan during the project preparation phase. The main objective of this Plan was to inform, consult and agree with indigenous communities, and local and environmental authorities on the activities developed by Empresas Publicas de Medellin, as well as to carry out the formal consultation required under Colombian law.
A summary of the Social Management Plan follows.

Summary of Social Management Program		
Program	**Objectives**	**Project**
Information and communication program	1. To inform communities on the project, its characteristics and stages 2. To establish harmonic relationships between communities and the project sponsor. 3. To encourage community participation.	a) Information, communication and dissemination of the wind project. b) Reception and resolution of claims c) Field visits to follow up the construction process
Employment opportunities program	Improve community income	a) Direct employment (recruitment and hiring) b) Indirect employment (acquisition of raw materials, goods and services)
Environmental education program	To promote sustainable development	a) Dissemination of the EMP for employees and communities b) Training on design of environmental projects c) Ethno education projects d) Training on management of reservoir of water e) Training on solid waste disposal f) Training on adequate use of natural resources
Participation and community strengthening program	1. To strengthen communities 2. To facilitate communities' access to financial resources	a) Training on indigenous rights according to Colombian law b) Training on formulation, implementation and assessment of self management projects to access legal transfers and additional PCF benefits
Information and Training for employees program	To respect the cultural characteristics of communities	a) Training on cultural life of Wayuu people to employees and contractors
Compensation Program	1. To compensate for the use of land and resources 2. To improve the standard of living	a) Water desalinization plant b) Water storage c) School rehabilitation d) Health Center rehabilitation e) Rehabilitation of graveyard
Technology Dissemination Program	To inform and disseminate the advances of the new technology	a) Field visits to the wind power plant b) Dissemination of material on new technology

F.2. If impacts are considered significant by the project participants or the host Party:

Please provide conclusions and all references to support documentation of an environmental impact assessment *that has been undertaken in accordance with the procedures as required by the host Party.*

The environmental impacts of the project are not considered significant. The EIA was completed in accordance with Colombian law. The government endorsed the project with official communication issued by the Ministry of Environment.

G. Stakeholders comments

G.1. Brief description of the process on how comments by local stakeholders have been invited and compiled:

The EIA was conducted under the requirements established in the *Decree 1320 of 1998* relative to ethnic minorities and *Agreement 169 of 1989* of the International Labor Organization (ILO) that calls for mandatory consultation processes and the participation of indigenous communities during the development of environmental assessments.

Empresas Publicas de Medellin developed an extensive consultation process during the period 1999-2002. This consultation process included national, regional and local governmental institutions concerned with indigenous peoples, and traditional authorities and communities of Rancherías Kasiwolin, Arutkajui and Media Luna. The first consultation regarded the installation of the wind monitoring devices in 1999. The consultation process continued during all the phases of the EIA. The methodology and scope of the EIA was consulted as well as the identification of the impacts and the measures to manage them. Empresas Publicas de Medellin carried out a total of 20 formal consultation meetings with communities and several meetings with governmental institutions. All the consultation meetings with the communities were carried out with translators. The consultation process finalized in June 2002 with an agreement on the Environmental Management Plan, which includes the physical, biological, socioeconomic, and cultural programs described above. The Ministry of Interior, Department of Indigenous Communities Affairs, supervised the consultation process.

No concerns were raised by any other stakeholders when the project was posted on the PCF website.

G.2. Summary of the comments received:

No concerns about the project were voiced by the local stakeholders during process described above.

G.3. Report on how due account was taken of any comments received:

Not applicable.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

(Please copy and paste table as needed)

Organization:	Empresas Publicas de Medellin
Street/P.O.Box:	
Building:	
City:	Medellin
State/Region:	
Postfix/ZIP:	
Country:	Colombia
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	
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First Name:	Luis Carlos
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Organization:	Prototype Carbon Fund
Street/P.O.Box:	The World Bank, 1818 H St., NW
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City:	Washington
State/Region:	DC
Postfix/ZIP:	20433
Country:	USA
URL:	www.carbonfinance.org
Represented by:	
Title:	Manager
Salutation:	Mr.
Last Name:	Newcombe
Middle Name:	

First Name:	Kenneth
Department:	
Mobile:	
Direct FAX:	+1.202.522.7432
Direct tel:	+1.202.473.6010
Personal E-Mail:	knewcombe@worldbank.org

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding in the Jepirachi Wind Power project.

Annex 3

NEW BASELINE METHODOLOGY

(The baseline for a CDM project activity is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity. A baseline shall cover emissions from all gases, sectors and source categories listed in Annex A of the Kyoto Protocol within the project boundary. The general characteristics of a baseline are contained in para. 45 of the CDM M&P.
For guidance on aspects to be covered in the description of a new methodology, please refer to the UNFCCC CDM web site.
Please note that the table "Baseline data" contained in Annex 5 is to be prepared parallel to completing the remainder of this section.)

1. Title of the proposed methodology:

"Least cost analysis and optimization modeling for renewable energy capacity additions to existing power systems"

2. Description of the methodology:

2.1. General approach *(Please check the appropriate option(s))*

□ Existing actual or historical emissions, as applicable;

□X Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;

□ The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

2.2. Overall description (other characteristics of the approach):

The proposed methodology identifies the applicable scenario that represents the baseline and the baseline emissions for the proposed addition of a renewable energy project of relatively small and uncertain capacity to an existing electricity grid.

The methodology makes use of the observation that cost minimization is often the driving factor in the planning and expansion of power systems through capacity additions and in the operation of existing electric generation system. Least-cost planning is typically the objective of expansion planning models such as SUPER/OLADE-BID, which is widely used in Latin America. Cost considerations play also a predominant role in deregulated power markets, where independent power developers and producers compete on costs. Projects and technologies with the lowest total costs per unit of electricity output (kWh) are likely to maximize profitability and thus represent an attractive course of action. This provides the rationale for the proposed methodology.

The methodology suggests that, in the described situation, a cost analysis is adequate to identify a baseline scenario that represents "an economically attractive course of action", as indicated in 48(b) CDM M&P. The methodology also conforms with the guidance contained in Annex C of the CDM M&P (Terms of reference for establishing guidelines on baselines and monitoring methodologies), which state on page 46 (paragraph c) that the Executive Board shall take into account (i) current practices in the host country or an appropriate region, and observed trends; and (ii) least cost technology for the activity or project category. Further, the methodology responds to the guidance on additionality tools provided by the 10th meeting of the Executive Board, July 29, 2003 (CDM-EB-10, Annex 1), because the methodology involves "a qualitative and quantitative assessment of different potential options and an indication of why the non-project option is more likely". ~~Also in response to EB10, the methodology is further enhanced by tools that aim to show that the proposed project faces barriers and is not common practice in the host country and is therefore not part of the baseline but additional.~~

The methodology includes also elements that elaborate on the baseline scenario and the applicable emission calculation methodology. It is inherently difficult in CDM projects that involve relatively small capacity additions to an interconnected electricity system to predict the impact a project will have on the timing of other capacity additions, on the retirement of plants and on the operation of the system. This is particularly true for deregulated power markets, in which investment and operational decisions are made on a day-to-day basis by independent individuals and in response to market signals and investor expectations. Therefore, the methodology proposes a modeling tool that predicts system expansion and operation and projects emission reductions. However, in the interest of accuracy, the methodology proposes to improve on these predictions during the operation of the project using monitored data.

Thus, the proposed methodology consists of the following four steps:

A. A analysis of the additionality of the proposed project using the additionality tools approved by the CDM EB. The analysis consists of the following three components: cost comparison; other barriers; and a common practice test.
B. Model runs of a least cost expansion-planning model: to elaborate on the likely development of the baseline scenario by projecting future system expansion with and without the project.
C. An assessment of the project's likely impact on system expansion: to determine that a dispatch analysis is appropriate to calculate emission reductions.
D. Model runs of a dispatch model with and without the project: to forecast baseline and project emissions and to project the anticipated emission reductions due to the project.

The proposed methodology can be used if the following conditions apply cumulatively:

1. The proposed project involves the addition of an electricity generation plant of relatively small capacity and uncertain availability (such as a wind farm, small hydro, run-of-river hydro, solar, etc.) to be connected to an existing electricity grid. Small capacity is defined in relation to overall system size; the methodology suggests a size of not more 30 MW as default value, unless it can be demonstrated that the capacity addition does not lead to a significant postponement of other capacity additions and/or accelerate the retirement of older capacity . Uncertain availability is defined in relation to whether the project's capacity is regarded as firm (i.e. always available to start and stop) or not.
2. The geographic and system boundaries for the relevant electricity system can be clearly identified.
3. Sufficient information on the characteristics of the relevant electricity system and on selected variables that impact system development is available in the host country.
4. The expansion of the electric system is either centrally planned and implemented using least cost planning tools, or independent power producers compete on costs in supplying the market through investments in capacity and electricity sales to a power pool and/or directly to end-users.
5. An expansion and dispatch model, which is adequate for the country's circumstances, is available and is operated by qualified experts with an adequate understanding of the country's energy system and access to the necessary data.
6. The project does not result in any significant leakage of CO2-emissons and/or increased emissions of non-CO2 greenhouse gases that would be significant in comparison with the baseline scenario. If this condition is not met or if a reduction in emissions other than CO2 from energy generation is claimed, the methodology must be supplemented with additional elements that are appropriate and which may have to be approved.

(A) Additionality test of the proposed project activity based on the additionality tools

This part of the methodology demonstrates project additionality by applying the additionality tools (b), (c) and (d) contained in CDM EB-10, Annex 1:

> "2. Examples of tools that may be used to demonstrate that a project activity is additional and therefore not the baseline scenario include, among others:
> (b) A qualitative or quantitative assessment of one or more barriers facing the proposed project activity (such as those laid out for small-scale CDM projects);…"
> (c) A qualitative or quantitative assessment of one or more barriers facing the proposed project activity (such as those laid out for small-scale CDM projects);
> (d) An indication that the project type is not common practice (e.g. occurs in less than [<x%] of similar cases) in the proposed area of implementation, and not required by a Party's legislation/regulations."

The project sponsor should assess whether the following conditions and barriers apply to the project. Quantitative and qualitative information and data should be used to document the existence of constraints and barriers.

The proposed project activity should be considered additional if it can be convincingly demonstrated that the project meets either one of two combinations of the following additionality tests:

The project is

- not the most economically attractive course of action (i.e. additionality tool (b) – 'cost comparison')
  or
- cannot be considered as common practice (i.e. additionality tool (d) – 'common practice test'),
  and
- is hindered by one or more barriers (i.e. additionality tool (c) – 'barrier analysis').

Or, the project is

- not the most economically attractive course of action (i.e. additionality tool (b) – 'cost comparison')
  and
- cannot be considered as common practice (i.e. additionality tool (d) – 'common practice test').

Additionality tool (b): *Is the project the most economically attractive course of action?*

The methodology uses a cost indicator to simulate an investment decision and predict its likely outcome. In doing so, the methodology identifies one of two plausible future scenarios as the economically more attractive course of action and thus as the baseline. The two alternatives are (a) the existing electric system with the proposed project and (b) the existing electric system without the proposed project. If the project involves higher generation costs than alternative expansion options, then scenario (b) is the applicable baseline scenario. If the project is a least-cost generation option, then scenario (a) is the applicable baseline scenario, and the project is part of the baseline and non-additional. Note that, at this stage, no claim is made that a lower-cost generation alternative than the proposed project would actually be implemented as part of the applicable baseline scenario, and consequently that it should be used to calculate baseline emissions.

The cost comparison is performed following these steps:

1. Confirm that the above conditions 1 – 5 are met.
2. Determine the geographic and system boundaries.
3. Identify alternative low-cost electricity generation technologies and projects available within the boundaries that can be used to help satisfy growing power demand.

4. Calculate expected total net generation costs for the project and its alternative(s) using the Electric Power Research Institute (EPRI) TAG formula:[2]

$$COE = \frac{CRF * I + O\&M}{E} \quad \left[\frac{US\$}{kWh}\right]$$

Where:
- *COE*: Levelized Cost of Energy ($/kWh)
- *I*: Total Investment cost of project accumulated by commissioning date
- *O&M*: Annual Operation & Maintenance costs of the plant
- *E:* Average annual generation of Energy (kWh)
- *CRF*: Capital Recovery Factor for discount rate *r* and number of years *n* (equivalent to the useful life of the plant): $CRF = \frac{r}{1-(1+r)^{-n}}$

Cost figures should be calculated on a per kWh basis and must include all construction, operating and maintenance costs as well as supplemental income[3] (except income from power sales and emission reductions). The compared alternatives must have the same expected lifetime. Assumptions (e.g. discount rate) must be the same for all compared alternatives. Theses assumptions should more likely underestimate than overestimate the true cost of the project, whereas the true costs of the alternatives should be more likely overestimated than underestimated, such that assumptions create a bias for the project being least-cost and non-additional.

5. Compare the cost figures and conclude, if possible, that the proposed project is not economically as attractive as the examined alternatives and therefore not part of the baseline.

Additionality tool (c): *Is the project hindered by one or more barriers?*

This part of the methodology proposes a qualitative and/or quantitative analysis to demonstrate that the project faces significant barriers, which make its realization without CDM support highly unlikely.

The methodology identifies the relevant barriers by asking questions about risks relating to the project, lack of funding, lack of experience and capacity, and lack of priority of project technology in the host country.

c.1 Managerial barrier: *Is the project hindered by lack of domestic managerial capacity and experience with the project technology and project type in the host country*?

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[2] It may also be possible to use other costing formula, which however are not part of the proposed new methodology.

[3] Costs should be adjusted for income if this is necessary to obtain cost figures that are comparable between power options. Income may, for instance, include revenues from the sale of co- or by-products (e.g., sugar in sugar mills that produce power from bagasse).

The project proponent should demonstrate that no domestic power companies are currently employing the proposed technology in the host country. If this cannot be demonstrated, it should be concluded that this barrier is not relevant for the proposed project.

c.2 Investment barrier: *Is the project unable to access funding due to, among other things, high country risk or low domestic savings, or discouraged by high interest rates (in real terms), or are only loans with short pay back period available?*

The project proponent should document that the host country is rated as a high risk country by international credit rating companies, that the country experiences an outflow of existing resources (i.e. remission of local and foreign savings and investments) from the country and the lack of new resources coming into the country, that long-term capital (e.g. 15 years or more) is unavailable in the country, and that long-term credit lines and bank loans are unavailable for project investments and working capital requirements. If not possible, it should be concluded that this barrier is not relevant for the proposed project.

c.3 System barrier: *Is the project technology not considered important (for reasons of system mix of generation resources; dispatchability, firm/non-firm, etc.) from the point of view of the system operator?*

The project proponent should document that the system operator/dispatcher considers the project less attractive from a system operation and system reliability point of view. If not, it should be concluded that this barrier is surmountable by the project.

c.4 Resource barrier: *Is the renewable energy resource readily exploitable by the project developer?*

The project proponent should demonstrate that geological, hydrological, wind and other necessary data for project development purposed are insufficient, unavailable or non-existent for the region or host country in which the project is located. If, on the other hand, the required information and data is available, it should be assumed that this barrier is not relevant for the proposed project.

c.5 Other barriers: *Is the project hindered by other barriers including, for example, institutional, financial, capacity, prevalent practice, or regulatory barriers?*

The project proponent should convincingly demonstrate that the project is hindered by one or more constraints relating to institutions, financing, capacity, prevalent practice or regulatory policies. If the project proponent cannot produce a convincing analysis, it must be assumed that this barrier is not relevant for the project.

The information which should be used to document the above barriers include official statistics, government reports, national and international public financial and monetary organizations, national and international private banking and financial organizations, policy studies, scientific journal articles, articles in professional journal, newspapers, expert opinion.

In the absence of a quantitative assessment, the methodology relies on expert judgment of the Operational Entity validating the project to confirm that the claims of significant barriers are plausible and supported by convincing evidence.

Additionality tool (d): Common practice test:

d.1 National regulation: *Is the project technology not required by the host country's legislation or regulation?*

and

d.2 Market penetration rate: *Will the project use a technology, or an energy resource (fuel), that currently contributes, or within 3 years is expected to contribute, less than 5% of the total generation (GWh) coming from at least 5 power plants in the host country?*

The information which should be used to document penetration rates include official statistics, government reports, policy studies, and scientific journal articles.

(B) System expansion model

This part of the methodology elaborates on the baseline and its likely development using a computerized optimization model, which determines the optimal least-cost system expansion strategy, taking into account several variables including plants under construction, retirement plans for existing plants, cost information provided by the major generators, demand projections, fuel prices and other conditions. The model thus establishes the baseline as the existing system plus a sequence of plausible capacity expansion options as determined by the model. The result can show that the model does not select the proposed project for implementation within the time under study.

The predictive ability of expansion models is limited, because the model output depends on input assumptions about system features and future developments, which may be inaccurate or simplifications. The model output can therefore not be guaranteed, but is believed to deliver the most accurate prediction at the time.

~~Although different expansion planning models exist and are used for expansion planning purposes, the proposed new methodology is restricted to the Super-OLADE / BIDS model, which is developed and maintained by the Latin American Energy Agency (OLADE); it is widely used in Latin America. A more detailed description of the model is contained in Annex 5.~~

(C) Impact of the project on system operation and expansion

This part of the methodology involves a qualitative and or quantitative assessment of the impact that the implementation of the project will likely have on system expansion and operation. The expansion model can be used for the quantitative assessment: By forcing the proposed project into a model run, one can determine whether the project has any impact on capacity additions or retirements in comparison with the model runs without the project.

A qualitative assessment reflects on the typical impact of capacity additions, which depends on the characteristics of the existing system and plans for its expansion as well as on the operational features of the project as part of the expanded system. The following table summarizes possible reactions to new capacity in different power system environments.

Impact of new capacity … Characteristics of existing system	… on system operation and dispatch	… on retirement of existing capacity	… on capacity additions	Total impact
Undersupply	No effect on existing operation and generation	No effect on retirement, new capacity fills supply gap	No impact	No impact until undersupply situation is resolved
Equilibrium with adequate supply margin	Reduced genera-tion by less favourable plants (higher operational costs)	Retirement of old, less favourable capacity (higher operational costs)	Elimination or postponement of other new capacity	Mixed effect, adjustment of generation more likely (depending on project characteristics, e.g. size, reliability, operational cost, and expected demand growth).
Oversupply	As above	Increased pressure to retire capacity	Increased elimination, postponement	Mixed effect, elimination and postponement more likely.

New capacity can have three effects, which are likely to develop over time and in the following order in electric systems where supply and demand is in equilibrium and not much demand growth is expected:

- Adjustment and reduction in generation, predominantly at existing high cost plants: This is probably the first reaction of the system, in particular for relatively small capacity additions of uncertain reliability or for plants that offer non-firm capacity such as a wind farm.
- Retirement of existing plants with high operational costs: This adjustment is likely to occur as a result of shifts in operational conditions, where plants with high operational costs go increasingly ideal and fail to cover costs.
- Postponement or elimination of other planned new capacity elsewhere: This adjustment is likely to develop over time as the impact of the new capacity on the system's operation becomes apparent. In particular, capacity additions that offer non-firm energy, such as a find farm, need to be backed up by firm capacity and can thus not replace or delay capacity. The length of the planning cycle for power plants, the

inherent lumpiness of new plants (often 150 MW and larger), and the uncertainty of demand growth render a quick capacity reaction less likely, unless major unexpected (CDM) capacity accumulates quickly in the system.

Developing countries with fast growing power demand are often on the brink of facing undersupply situations, with the gap often being filled by high cost marginal power such as from diesel engines. Typically, much larger capacity additions are needed to balance demand and supply than can be added by small to mid-size, relatively uncertain renewable energy CDM projects considered here. In additions, host countries typically prefer the elimination of dirty and expensive marginal power sources to the postponement of major capacity additions.

Ultimately, which mix of reactions to new CDM capacity will prevail in a given country's power system over time is inherently hard to predict, in particular where the market reaction is mediated by price signals and individual decisions, and by the host countries regulatory system for the power sector. Therefore, the choice of the baseline scenario, which is taken as the basis for selecting an appropriate concept for the calculation of baseline emissions, must sometimes rely to some extent on plausible assumptions, which can only partially be checked through subsequent monitoring.

The proposed methodology therefore allows project proponents to advance arguments in favor of one or the other type of system reaction as the basis for selecting a calculation method for baseline emissions that reflects the likely impact of the project on the system. The proposed methodology relies on Operational Entities to check the plausibility and conservativeness of the assumptions and results.

(D) Projection of emission reductions using a dispatch model

This part of the methodology involves the projection of baseline emissions and emission reductions using a dispatch model. Although alternative calculation methods for baseline emissions can be used (such as the average of build and operating margin), the present methodology is limited to the use of a dispatch model and the subsequent monitoring of actual dispatch behavior. The methodology can therefore only be used for projects and situations where the CDM capacity addition will most likely lead to operational adjustments in the power system and not to capacity modifications.

Where this is the case, a dispatch optimization model, such as SUPER/OLADE-BID, can be used to compare the dispatch in the baseline and project situation. The model should contain an operational module, which is run with the input from the capacity expansion modules to simulate least-cost dispatching for the system with and without the proposed project. The emissions in both situations are then calculated, and their difference is taken as the projection of emission reductions.

In line with the use of the dispatch model, the present methodology proposes to undertake *ex post* monitoring of actual dispatch behavior to improve accuracy of the data. This data reveals the power source or sources that would be called upon should the project not generate and it therefore revels the operational conditions that would prevail without the project. (See Annex D for details.)

Time dimension of the baseline

The baseline scenario and the additionality of the proposed project can change over time. There is always a possibility that the project would be implemented without the CDM support at a later date. The proposed modeling tools already consider the time dimension of the baseline. In addition, the cost comparison and other indicators of barriers should be assessed sufficiently conservatively, so that a fundamental change in conditions is unlikely to occur during the crediting period of seven years. Therefore, the present methodology does not include a reassessment of the baseline before the end of each seven-year crediting period.

3. Key parameters / assumptions (including emission factors and activity levels), and data sources considered and used:

The above baseline methodology requires the following input information, the correctness of which is to be confirmed by a Designated Operational Entity.

- Information on the power sector conditions, in particular capacity investment conditions, system operation and reliable dispatching information. *Data source*: Project proponent, country reports, government agencies, international organizations etc.
- Cost calculation for the proposed project (as explained above). *Data source*: Project proponent, feasibility study and other relevant project planning information.
- Cost information for alternative low cost system expansion options and technologies available to the country. *Data source*: National utility or sector planning authority, information from technology suppliers, independent experts, planned power projects in the country etc.
- For strongly hydro-based power systems, information on historical hydrologic conditions (and equivalent information for other renewable energy sources). The optimisation model uses this information to predict future hydrologic conditions. *Data source*: national hydrological agency or department.
- Demand projection: *Data source:* National utility or sector planning authority, independent experts, etc.
- Estimate of evolution of fuel prices: *Data source*: National utility or sector planning authority, international organizations, independent experts, power developers in the country etc.
- Consideration of transmission and regulatory constraints, which may affect dispatching or capacity expansion, and in particular whether such constraints are expected to change during the period of analysis. *Data source*: National utility or sector planning authority, independent experts.

- Emission factors for individual power plants operating in the host country. *Data source*: National utility or planning authority, power producers, technology providers (boiler-plate efficiency), international organizations, and IPCC for default values.

4. Definition of the project boundary related to the baseline methodology:

(Please describe and justify the project boundary bearing in mind that it shall encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the project activity. Please describe and justify which gases and sources included in Annex A of the Kyoto Protocol are included in the boundary and outside the boundary.)

CDM projects have two different boundaries: one for the determination of the baseline scenario and another for monitoring and calculation of ERs. These boundaries do not have to coincide. The determination of the project boundaries depends on the project circumstances under which a baseline methodology is used.

The boundaries for baseline determination usually used for electric power capacity expansion projects define where possible alternatives to the proposed project are likely to be found. The methodology therefore suggests developing theses boundaries along the following lines:

- *Geographic boundary*: The country's (or region's) territory (for transnational system possibly also the relevant territory of neighboring countries), where power expansion facilities could be located and would compete with the proposed project.
- *System boundary*: The country's (or region's) interconnected power system (for transnational system possibly also the relevant system in neighboring countries), into which the proposed project would feed power and where it would displace the power generation of other sources.
- *Time boundary*: Current situation and planning cycle for a reasonable number of years (e.g. 7 or 10 year and up to 21 years in line with the CDM crediting periods).
- *Gases and sources of emissions, leakage*: The methodology addresses only CO2 emissions from grid-connected electricity generation. The methodology does not support claims of emission reductions from other sources or gases. Given the above system boundaries, a significant increase in GHG emissions outside of these boundaries (leakage) is considered unlikely (compare Section 7 below). The methodology requests demonstrating that other possible sources of leakage are insignificant and not measurable; specifically CO2 and other GHG emission from manufacturing and construction activities are considered insignificant for the described type of projects. If significant leakage is detected, the methodology demands adjustments and corrections, which may require supplementing the methodology by appropriate elements (condition F. in Section 2.2).

5. Assessment of uncertainties:

(Please indicate uncertainty factors and how those uncertainties are to be addressed)

The proposed methodology can lead to an erroneous baseline scenario if:

- Any of the conditions set out in **2.2** above are not fulfilled.
- Assumptions, parameters, data etc. listed in **3.** above are not correct or complete.
- Costs or modeling results are calculated incorrectly.

– The expansion planning and dispatch optimization model is not used correctly.

The designated operational entity must carefully check all assumptions used to ensure a conservative result. The careful assessment of the project circumstances and confirmation by an Operational Entity of the validity of the discussion and the conclusions drawn is imperative to mitigate risks and ensure credibility of the result.

Overall, the uncertainties associated with this methodology appear to be mitigated by the fact that the (a) methodology uses several avenues to identify the baseline and confirm additionality, and (b) some aspects of the baseline will be monitored ex post with greater accuracy, so that the determination of baseline emission factors does not rely on projections over a long time horizon.

6. Description of how the baseline methodology addresses the calculation of baseline emissions and the determination of project additionality:
(Formulae and algorithms used in section E)

The proposed methodology addresses the calculation of baseline emissions in the following ways:

(1) The methodology elaborates the most likely baseline scenario to the extent possible using a computerized expansion-planning model and by assessing the likely impact of the project on the future configuration of the power system and its operation. The application of the methodology is expected to confirm that the project's impact will predominantly lead to modification in system operation instead of expansion.
(2) The methodology calculates the projected baseline emissions (and emission reductions) through the use of a dispatch optimization model.
(3) The methodology proposes to monitor operational conditions *ex post* to obtain accurate information on actual dispatch, which indicates the plants that would have generated power in the absence of the project. This *ex post* procedure serves to increase the accuracy of emission factors and the calculation of emission reductions.

The *ex post* monitoring and calculation of baseline emissions is justified, because on the one hand the future development of power systems and the impact of new capacity on the system is inherently difficult to predict and the predictions of planning models regarding systemic changes, future system expansion and operational modifications are inherently uncertain, and on the other hand, because information on the actual development and operation of the power system is relatively easy to obtain through monitoring and can significantly improve predictions and projections in situations where the impact of the project on the system's development is relatively small and its nature and direction relatively well understood. Ex post monitoring uses the developments that are not affected by the project but unknown at the planning stage to improve the accuracy of the calculated baseline emissions.

The baseline methodology uses qualitative and quantitative assessments to determine that the project is less likely to occur than the non-project option (i.e. the baseline). In particular, the methodology shows that the project is not the least cost option and that it faces other barriers to implementation. This leads to the conclusion that the project is not the baseline and is, therefore, additional. (For details see 2.2 above).

Further details on the ex post determination of baseline emissions are contained in Annex 4 and in the Monitoring Plan for the project.

7. Description of how the baseline methodology addresses any potential leakage of the project activity:

(*Please note: Leakage is defined as the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary and which is measurable and attributable to the CDM project activity.) -- (Formulae and algorithms used in section E.5)*

The methodology addresses leakage by defining the relevant boundaries (see above) and identifying relevant sources of emissions outside of these boundaries. Since the project boundaries encompass the entire electricity system of the region or country, no leakage outside of these boundaries in identified unless the export and import of electricity is affected by the project in a way that would lead to higher emissions abroad. However, it is not discernable how the addition of renewable power capacity would lead to leakage in the baseline. Conversely, leakage in the project scenario is possible, and, if measurable and significant, the methodology proposes to adjust project emissions summarily for leakage or include a methodology for monitoring of leakage in the monitoring plan and require the correction of the emission reductions for any net leakage.

8. Criteria used in developing the proposed baseline methodology, including an explanation of how the baseline methodology was developed in a transparent and conservative manner:

The proposed baseline methodology involves an application of investment analysis, which aims at identifying the economically most attractive course of action (see Art. 48b) using some measure of attractiveness such as the internal rate of return or the costs of the various options. Because alternative capacity additions are not necessarily under the control of a single investor, the methodology undertakes a system-wide cost comparison of alternatives power options. Thus, it determines whether the power system with or without the project would be the more attractive course of action. The methodology was further enhanced in response to EB guidance by introducing a barrier analysis and modeling tools to elaborate the baseline scenario and predict the emission reductions.

The following criteria were used in developing this methodology:

(a) *Realistic simulation of power sector development*: The objective of power sector planning and/or regulation is usually to ensure power supply at lowest economic costs, and private competition is encouraged to lower production costs. The proposed methodology recognizes this objective by assuming that the power sector baseline is represented by the least cost system expansion.

(b) *Increased accuracy through the use of a broad information base, standard modeling tools and ex post monitoring*: The methodology makes use of a wide variety of available information and a standard modeling tool, which reduce uncertainty by cross checking results. The use of a standard optimization model reduces the role of individual judgment and reduces the impact of random external variables that may have an impact on the expected optimal expansion plan. *Ex post* monitoring further increases accuracy through the use of real data and minimizes the reliance on projections as much as possible.

(c) *Potential for replication and standardization*: The methodology has the potential to be replicated for similar projects or bundles of projects in the same country.

The proposed baseline methodology is transparent and conservative, because:

- The methodology can be applied in a transparent manner: it relies on and discloses conventional cost and data analysis, which Designated Operational Entities can check to ensure completeness, correctness, plausibility and conservative assumptions and for which input data can be audited.
- The methodology can be applied in a conservative manner: assumptions such as cost estimates, discount rates, input into the optimization model etc. can be made in such a way that a wrong assessment of additionality and an overestimation of emission reductions is most likely avoided.

9. Assessment of strengths and weaknesses of the baseline methodology:

Strengths:

- See No. 8 above, in particular: realistic simulation of power sector development, increased reliability through use of a broad information base and modeling tools combined with *ex post* calculation of baseline emissions.

Weaknesses:

- The methodology does not detect motives and other idiosyncrasies of investors interested in a particular project. This appears acceptable, because idiosyncrasies cannot be validated.
- The methodology involves a more elaborate *ex post* monitoring concept (as opposed to the determination and fixing of a baseline emission factor at the project preparation stage). But project participants may wish to invest more in monitoring activities to reduce the need for conservative assumptions and low default factors, which would decrease the emission reductions yield.

10. Other considerations, such as a description of how national and/or sectoral policies and circumstances have been taken into account:

- The methodology takes the effect of current and expected future conditions in the power sector of the host country into account, since it compares the project with plausible low cost capacity expansion options that are realistically available to the host country and uses models and assumptions that are typically used in the country for the purpose of power sector development.

- The *ex post* monitoring methodology automatically detects the impact of national and/or sectoral policies and circumstances on system operation and expansion.

Annex 4

NEW MONITORING METHODOLOGY

Proposed new monitoring methodology

(Please provide a detailed description of the monitoring plan, including the identification of data and its quality with regard to accuracy, comparability, completeness and validity)

Title of the proposed monitoring methodology:

"*Ex post* dispatch analysis for renewable power projects in integrated electric systems"

This monitoring methodology and the associated algorithms for the calculation of baseline emissions and emission reductions can be used if the following conditions are fulfilled:

(a) The methodology is based on the elaboration of the baseline scenario for renewable power projects in integrated electric systems and represents emissions in this baseline scenario with high accuracy.
(b) The new capacity will – due to its size (by default 30MW or less - unless it can be demonstrated that the capacity addition does not lead to a significant postponement of other capacity additions and/or accelerate the retirement of older capacity), operational conditions or other factors – only affect the operation and generation of existing electric plants and not lead to a significant postponement of other capacity additions and/or an accelerated retirement of older capacity.
(c) The introduction of the new capacity does not lead to a significant modification of the dispatch system or of the behavior of participants in the electric system, so that through the monitoring of the dispatch system it is possible to observe, reconstruct or conservatively represent the dispatch that would occur in the absence of the project.
(d) The *ex post* monitoring and calculation of emission reductions is justified, e.g. by improvements in the reliability of data and increased accuracy of the calculation of baseline emissions and emission reductions as compared with *ex ante* estimates.
(e) Actual dispatch data and emission factors for marginal plants will likely continue to be available from the central dispatcher or from other sources.

1. Brief description of the new methodology

(Please outline the main points and give a reference to a detailed description of the monitoring methodology).

The proposed monitoring methodology builds on the observation that the capacity expansion project replaces electricity that would otherwise be generated and dispatched to the grid by other power plants. The methodology relies also on the observation that the rules governing the dispatch and/or the actual dispatch behavior can reveal information on the plants that would be dispatched if the power output of the project became unavailable at any time.

In simple terms, the monitoring methodology asks – and answers – the following question: which plant or plants would, hour by hour, be called upon to deliver electricity if the CDM project ceased to deliver power to the grid. The answer identifies those plants at the operating margin, the generation and emissions of which are replaced by the project.

In a second step, the emission factor of these marginal plants is used to calculate the baseline emissions that are avoided hour by hour, because the project exists and is operating. Multiplying the appropriate emission factors with the output the project sends to the grid each hour does this.

Notes:

1. The methodology is best applied in situations where small (relative to overall system capacity) and/or few CDM projects generate electricity that is injected into the same grid with little, if any, effect on overall capacity expansion.
2. The methodology cannot be used for projects that involve direct replacement or modification of capacity (e.g. efficiency upgrades, technology or fuel switch).
3. *More than one CDM projects*: If two or more CDM projects supply power to the same grid within the relevant boundaries and they use the methodology presented here, these projects must coordinate how they calculate emission reductions in order to avoid double counting of replaced generation and emission reductions at the dispatch margin. This can be done in one of the following ways. The calculation is best done centrally, i.e. a central entity calculates and communicates the emission factor for each CDM project:
    a. Participants of several CDM projects can attribute the emission reductions to each CDM project in a sequence, i.e. from the earliest to the latest registered CDM project in a reverse merit order. That is, the last (latest registered) project will replace the equivalent generation that would come on line first, if none of the CDM projects operated, the second to last project will replace the equivalent generation that would come on line second, if non of the CDM projects operated and so forth, and the first (earliest) project will replace the equivalent generation that would come on line last, if none of the CDM projects operated.
    b. Alternatively, project participants of several or all CDM projects that operate at the same time can agree to calculate and share an average emission factor for the generation that they collectively replace (which may be simpler, but possibly less fair if different sources with different emission factors are replaced in sequence).
4. *No reserve capacity:* If no reserve capacity can be identified that would allow to dispatch power in lieu of the project, the methodology uses information on expected capacity additions assuming one of the following options as instructed by the monitoring plan:
    (a) The next planned system expansion has already been implemented to maintain reserve capacity in the absence of the project. The plant(s) at the dispatch margin are determined under the assumption that this capacity expansion is included in the merit order in the position that would be determined by the dispatch center in line with applicable rules and regulations (usually as base load) and would operate accordingly.
    (b) A low emission default plant identified by the expansion model is assumed to meet the marginal demand in the absence of the CDM project.

The monitoring methodology should be implemented in the monitoring plan as follows:

1. Confirm that the proposed monitoring concept is appropriate for the project and its baseline scenario and that the above conditions are fulfilled.
2. Determine monitoring boundaries, sources of emissions in baseline and project scenarios and sources of leakage (if any).
   Note: The monitoring boundary defines where and for which operations monitoring data are to be collected and which emission sources are inside and outside of the boundaries (and hence what counts as leakage). For grid connected renewable power projects that use the above monitoring methodology, the monitoring boundaries are usually as follows:
   - *Geographic boundary*: The project site relevant for the project's construction and operation.
   - *System boundary*: The country's (or region's) interconnected system including power exports and imports (in transnational systems also the relevant systems of neighboring countries).
   - *Time boundaries*: The planned monitoring and crediting period.

3. Determine the variables to be monitored in accordance with the monitoring concept, and obtain emission factors and other technical parameters as needed to complete the calculation algorithm. Make conservative assumptions as necessary.
4. Include rules to guide monitoring and recording activities and quality control.
5. Provide algorithms, formulae and tools (e.g. spread sheets) and related instructions on data manipulation for the calculation of baseline and project emissions and emission reductions.

The methodology requires doing the following, which needs to be laid out in detail in the monitoring plan for the project:

1. Monitor, collect and/or calculate the following project data:
   a) Electricity dispatched to the grid by the project net of parasitic consumption, ideally recorded hourly to allow capturing changing load conditions over the daily cycle. Use a professional sealed metering device.
   b) Indicators for project emissions and leakage (if any), e.g. methane from reservoirs.

2. Monitor, collect and/or calculate the following baseline data:
   a) The merit order of operation for each power plant of the system. The merit order ("the order for stacking plants") is obtained from the national dispatch center, which elaborates it according to applicable rules and national regulations. It is suggested that the monitoring plan for the project inform about the dispatch system and the rules that are actually used in the given host country to generate the merit order and dispatch electricity.
   Note: The dispatch rules and their application cannot be included in the present methodology, because the methodology cannot impose any dispatch rules on a host country or its national dispatch center. The dispatch rules are independent of the CDM project. It is an empirical question whether the rules are actually used for generating the merit or dispatch order (the order for "stacking" of plants) and

whether the merit order is then used for dispatch purposes and reported correctly by the dispatch center.[4] The present methodology cannot be used if the national dispatch center does not generate a merit order or does not report on the sequence of dispatched plants or discontinues to do so.

b) The power that is dispatched from all plants in the system or that would be dispatched from (marginal) plants if they were called upon by the dispatch center. This data is obtained from the national dispatch center.

c) Emission factors for the marginal plants. Plant emission factors can sometimes be obtained directly from power producers or government sources. Emission factors can be calculated, if data on fuel type, fuel emission factor, fuel input and power output for each plant can be obtained. Emission factors can also be calculated using the energy efficiency of the plant in combination with IPCC data for calorific value and carbon emissions factors for fuels. The plant energy efficiency can be measured (using fuel input and power output data) or IPCC default values or the technology provider's boiler plate data can be used (conservative, because under actual operating conditions plants usually have lower efficiencies and higher emissions).

3. Use the merit order and the power dispatched data ~~collected data~~ to determine the plant~~s~~ that operate at the dispatch margin and the next plant in the merit order (ideally on an hourly basis) and calculate the power they would dispatch in the absence of the project. The next marginal plant would operate if the marginal plant is running at or near its full capacity. *Note* the following special cases:

- If no reserve capacity can be identified that could be call upon, the procedure above under Notes point 4 should be followed.
- If more than one CDM project delivers energy into the same grid, the procedure above under Notes point 3 should be followed.

4. Calculate:

a) Baseline emissions by multiplying the hourly power output of the project with the applicable emission factors for the plant or the plants operating at the margin during this hour.

b) Project emissions and leakage if any.

c) Emission reductions as the difference between baseline emission, project emission and leakage.

The baseline emissions are calculated as a sum product in the following way:

[4] The dispatch system for Colombia was described in Exhibit B, submitted previously along with the revision of the PDD in response to the draft recommendation of the Methodology Panel. The merit order is often generated on the bases of the operating costs of the power plants in the system or on the basis of bids received from power producers while taking other technical or regulatory requirements into account. The dispatch center typically "stacks" the power plants beginning with the lowest costs or bids (plants that will be dispatched first) to the highest costs or bids (plants that will be dispatched last). The dispatch order is usually generated weekly or daily.

Sum over all hours of:
The project's hourly electricity dispatched to the grid
X
The emission factors of the identified marginal thermal plants

The outline of the method to calculate emission reductions is as follows:

Hourly net generation output from the project (MWh)

⇩

Determination of additional thermal energy and plants that would have been dispatched if the project were not generating

⇩

Determination of Emission Factors (EF) for the involved marginal plant(s) (tCO_2 /MWh)

⇩

Calculation of hourly emission reductions generated by the project (tCO_2)

⇩

Calculation of net daily, monthly, and annual CO_2 emissions avoided by integration of hourly data (tCO_2)

The following table shows the calculations: The incremental generation is the capacity that the marginal plant and, if necessary, the next marginal plant in line can contribute, if the project were not generating. The incremental generation is calculated as the residual capacity.

The following table calculates hourly emission reductions, which the project operator sums up to produce and report the numbers for daily, weekly and monthly emission reductions. The notation is as follows:

G_J:	Generation of project *J*
EF_M:	Emission Factor for the marginal plant *M*
C_M:	Capacity of the marginal plant *M*
E_M:	Generation of the marginal plant *M*
EF_N, C_N, E_N:	Equivalent for the next marginal plant *N* (and so forth)

		B	C	D
	Calculation of ERs	**Every Hour**		
			EF*i* (CO2t/MWh)	**ER_J (CO2t)**
1	**Project Plant**	G_J		
2	**Marginal Plant**		EF_M	
3	Capacity (MW)	C_M		
4	Generation (MWh)	E_M		
5	Incremental Generation (MWh)	if $(C_M-E_M) >= G_J$, then = G_J else C_M-E_M		=B5*C2
6	**Next in Line Marginal Plant**		EF_N	
7	Capacity (MW)	C_N		
8	Generation (MWh)	E_N		
9	Incremental Generation (MWh)	if $(C_M-E_M) <= G_J$, then $G_J - (C_M-E_M)$ else = 0		=B9*C6
	Total Hourly ER			=D5+D9

Note: As calculations are done in MWh and Capacity expressed in MW, numbers coincide

2. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived

(Please add rows to the table below, as needed)

Project data:

ID number *(Please use numbers to ease cross-referencing to table 5)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
P-1	Electricity output of the Project	G_J	MWh	m	Hourly	100%	Electronic and paper	Crediting period plus 3 years	
P-2 (example)	Methane from reservoir	CH_4	t	e	annually	-	Electronic and paper	Crediting period plus 3 years	
P-3 (example)	Diesel consump-tion (e.g. transport)	D	t	c (from billing)	annually	100%	crediting period plus 3 years	Crediting period plus 3 years	

Note: Renewable energy projects may or may not give rise to emissions. For example, a wind farm may not emit any GHGs, whereas the water reservoir of a hydropower project may emit methane. But some renewable energy projects may use significant amounts of fuel for transport. Which data to collect or to use in order to monitor emissions from the project activity therefore depends to a large extent on project type and circumstances.

Baseline data:

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
B-1	Capacity of each plant in the NIS	C_i (C_M, C_N, …)	MW	External report	Annually	100%	Electronic and paper	Crediting period plus 3 years	IPP, government, dispatch report
B-2	Dispatch of electricity from each power plant in the NIS	E_i (E_M, E_N …)	MWh	M	Hourly	100%	Electronic and paper	Crediting period plus 3 years	Dispatch report
B-3	Dispatch order as observed and indicated by dispatch rules		Names, dispatch rank order of plants	M	Daily	100%	Electronic and paper	Crediting period plus 3 years	Dispatch report
B-4	Energy efficiency of marginal plants	E_i	% or TJ/GWh	External report	Annually	-	Electronic and paper	Crediting period plus 3 years	IPP, government, IPCC, manu-facturer data
B-5	Emission factor of marginal plants	EF_i	tCO2e/ MWh	C	Annually	100%	Electronic and paper	Crediting period plus 3 years	Plant efficiency (*Ei*), IPCC data for calorific value and carbon emission factor for fuels.

Note: A table with monitorable baseline data is incorporated here, because the methodology proposes ex post monitoring of baseline emissions.

3. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources
(Please add rows to the table below, as needed.)

The monitoring boundaries often do not include the construction phase of the project and associated emissions (outside of geographic or temporal boundary) or life cycle emissions of equipment used or emissions from transportation, in which case these emissions may be classified as leakage. For renewable energy projects, emissions outside of the project boundaries are usually not significant and/or reasonably attributable to the project activity. But where they are (possibly in the case of construction or transportation emissions), similar emissions may also occur in the absence of the project (e.g. from mining and transportation of fossil fuel or construction of alternative capacity) – and reductions in these baseline emissions are often not claimed, in which case the net leakage effect can often be zero or negative and need not be monitored.

Note: Which data is monitored to determine leakage will typically depend on project type and circumstances. The table below therefore contains only an example.

ID number *(Please use numbers to ease cross-referencing to table 5)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
L-1 (example)	Emissions from project constructio n	-	tCO2	e	Once: for first verificatio n	-	Electroni c and paper	Creditin g period plus 3 years	

4. Assumptions used in elaborating the new methodology:

(Please list information used in the calculation of emissions which is not measured or calculated, e.g. use of any default emission factors)

The methodology can use IPCC or other default factors to describe the energy efficiency of power plants.

5. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored. *(see tables in sections 2 and 3 above)*

Data *(Indicate table and ID number e.g. D.4-1; D.4-2.)*	Uncertainty level of data (High / Medium / Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
P-1	Low	Yes	Electronic commercial metering compliant with relevant standards and best practices to be used.
B-1	Low	Unknown	Official data shall be used, which is considered accurate. No additional QA/QC procedures by project participants.
B-2	Low	Unknown	Official data - considered accurate - no additional QA/QC.
B-3	Low	Unknown	Official data - considered accurate - no additional QA/QC.
B-4	Low	Unknown	Official data or default values - considered accurate / conservative - no additional QA/QC by project.
B-5	Low	Yes	Recalculated by an Operational Entity. Assumes that energy efficiency data (B-4) is accurate.

6. What are the potential strengths and weaknesses of this methodology?

(Please outline how the accuracy and completeness of the new methodology compares to that of approved methodologies).

Strengths: The methodology

- Takes actual developments into account to determine baseline emissions and thus allows a more accurate, yet conservative, calculation of emission reductions compared to *ex ante* projections.
- Reduces project level monitoring to a reading of electricity meters and, if necessary, collection of data on project emissions and leakage.

Weaknesses: The methodology

- Requires coordination if several CDM projects feed power into the same grid in order to avoid double counting of power replaced by the projects.
- Can only be used if central dispatcher and other agencies cooperate and supply the necessary data.
- May involve handling of a large volume of data if monitoring is done hourly and no automated data handling and calculation system is used.

7. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

This monitoring methodology is also used in a PCF hydropower project in Chile (Chacabuquito), which has already successfully undergone verification of emission reductions.

After completing above, please continue filling sub-sections D.2. and following.

Annex 5

TABLE: BASELINE DATA

(Please provide a table containing the key elements used to determine the baseline (variables, parameters, data sources etc.). For approved methodologies you may find a draft table on the UNFCCC CDM web site. For new methodologies, no predefined table structure is provided.)

A. Cost comparison

The baseline scenario was determined on the basis of a comparison of costs of alternative generation options. The table shows the assumptions made in the calculation of costs for the project and for three low-cost thermal alternatives. Costs were calculated using the SUPER/OLADE-BID optimisation model method as outlined in Annex 3, No. 2.2. More information on key parameters, assumptions and data sources is contained in the attached baseline study.

Calculation of Generation Costs for Jepirachi and Thermal Options:

Type	Installed Capacity (MW)	Avg. Generation Cost (USD/MWh)
CCGTs	150	32.82
	200	31.99
	300	31.50
OCGTs	150	36.50
	200	36.50
	300	36.50
Coal	150	35.30
Jepirachi	19.5	38.35

Assumptions:
Economic Parameters: The data provided in this table assumes an average utilization factor of 0.7 over the project lifecycle, discount rate of 10%, a project economic life of 25 years and it also includes taxes. Source: Unidad de Planeacion Minero Energetica (UPME).
Efficiency and plant factor of equipment: According to state-of-the-art of the equipment and reasonable utilization.

B. Application of SUPER/OLADE-BID

The Super OLADE / BIDS model is a mathematical program developed and commercialised to determine the optimal stochastic operation policy of a multi-reservoir hydrothermal electricity system.

The model can be used to produce expansion strategies which take into account risks and uncertainties in variables such as demand growth, project costs, fuel costs, construction schedules and hydrological behavior.

The SUPER/OLADE-BID model includes the following modules:

Table X: SUPER®/OLADE-BID: modules and sub-modules

Module	Features
Demand and Energy Conservation	Simulates demand curves given historical data. It also simulates energy conservation programs.
Hydrologic Module	Considers historical hydrologic series, reservoir levels and storage capacity per plant, for different seasons and generates hydrologic sequences for the dispatch module.
Expansion Planning	Generates an expansion plan strategy given uncertainty, financial constraints, risks and other critical factors.
Thermal Generation	Generates least cost planning explicitly considering elements of uncertainty.
Operation	Simulates least-cost dispatching for both hydro and thermal power plants.
Financial	Integrates company financial management with expansion planning.
Environmental	Compute environmental impacts associated to optimum least cost dispatching and compare generating alternatives

In Colombia, the Energy Planning Unit (UPME) has conducted a simulation under conservative assumptions with the SUPER/OLADE-BID model to determine the ideal expansion strategy for the system.

UPME followed two steps to determine the ideal expansion strategy taking into consideration conservative assumptions:

Step 1 Run the Expansion Planning Module

The simulation results provide with an indication of the amount of capacity as well as the types of capacity that should be added to the system not only to supply the demand but also to maintain minimum reliability levels (e.g. an specified reserve margin level).

The results of the model are compared with the data provided by participant private and public generating companies regarding possible future capacity additions in their portfolios. This steps allows UPME to check investments and probable dates of capacity additions in order to adjust the expansion plan accordingly (i.e. the expansion plan is therefore closer to reality).

Step 2 Run the Operations Module

UPME runs the operations module with the results from Step 2 to simulate the dispatching operation and estimate the carbon emissions associated to resulting merit order structure.

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