

## Financial Feasibility For The Sale of Certificates of Reduced Emissions (CER's) In Carbon Markets, Using The Analytical Hierarchical Process (AHP). Wind Power Energy Case

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**Abstract:** Observing the current situation of energy in Paraguay while the Kyoto Protocol was in force and taking into account the almost zero International presence in the Energy Project Certification process. The results of the National Energy Balance prepared by the National Electricity Administration (ANDE), in which it is concluded that hydraulic energy would be available to cover the load demand until the year 2035, makes it necessary to search for new alternatives for the generation of electrical power [15]. The purpose of this article is to demonstrate the financial feasibility of the sale of Certificates of Reduced Emissions (CERs). In order to certify energy projects of electricity generation in which the use of unconventional energy (Wind Power Energy) is proposed. This energy will be coming from a Park of Wind Energy with a power of 46MWe. It will be searched the most convenient carbon market for the sale of certificates using the Hierarchical Analysis Process (AHP) as a tool [13]. The Certification Mechanism and the Legal Framework under which the sales of CERs in Carbon Markets will be governed are not yet defined. It is estimated that it will be so until 2020, according to the conclusions resolved during the Conference of Parties (COP21). This event took place in the City of Paris (France) in the month of December of the year 2015. However, for a more comprehensive analysis, the Clean Development Mechanism (CDM) will be used as a mechanism for certification. It is important to take into account that while it was in force in developing countries, it was the most used mechanism according to the Economic Commission's indicators, for Latin America and Caribbean (LAC)

**Keywords:** Carbon Market, Voluntary Market, COP21, European Market, CER's, Wind Power Energy, CDM.

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### I. Introduction

Observing the global climate situation, caused by Greenhouse Gases (GHG) and with it Climate Change with its negative externalities on the environment, along with the lack of definitions regarding mitigation and adaptation mechanisms. These hinders the formulation of public policies that help resilience in some countries. At the local level, the lack of implementation of an Energy Policy with a short-term sustainable vision is restricting the adequate use of Electric Power available in Paraguay. Additionally, the inappropriate use of the existing Electric Power in the absence of a Sustainable Energy Efficiency Policy. Both constitute obstacles for the planning and placement of energy as a product in the Electricity Market of neighboring countries. On the other hand, the sources of electricity generation are 100% renewable. This makes it possible to certify in the Carbon Market, by not emitting CO<sub>2</sub> and thereby achieve foreign exchange income, not only with the sale of electricity, but also with the sale of Certificates of Emissions Reduction (CER's). The indicated could position Paraguay, currently a developing country under a sustainable vision, in a model country in the region, with a diversified energy matrix with 100% renewable energy. It would be possible through the sale of certificates of Reduced Emissions in the modality of Commodities and with this increase the Gross Domestic Product (GDP).

Mentioned this background, this article focuses on finding the most convenient carbon market to commercialize the CERs. As mentioned above, Paraguay does not have experience with certified energy projects through the CDM nor have there been concrete advances in COP 21 and COP 22. Thus, the rules are still not clear in the Carbon Market and the ways it would come into effect after 2020. The mitigation mechanism, the adaptation mechanism and how the disbursements of green funds would be, are difficult to predict. This article through a scientific study seeks to find through the theory of the Hierarchical Analysis Process (AHP), the most accessible carbon market to commercialize CERs. Obtained through the CDM, under the criterion of political viability; technical viability; legal feasibility; economic viability; having as options: the European Market; American Market; Voluntary Market.

There are two types of carbon markets: regulated compliance and voluntary markets. Companies and governments that, by law, have to account for their GHG emissions use the regulated market. It is regulated by mandatory carbon reduction regimes, whether national, regional or international. Taking into account that green funds operate and operate under very complex mechanisms, international agreements firms help in the political viability and economic viability for the certification of energy projects. With regard to technical feasibility and legal viability, the installation of maquiladora companies in Paraguay helps in the transfer of knowledge and interacts with the regulations in force in the country; criteria that will be taken into account to opt for the Carbon Market more convenient for the sale of certificate.

## **II. Theoretical Framework**

The carbon credit market arises from the idea of negotiable emission permits, initially formulated by Valles in 1968 and later developed by Tietenberg in 1985, Baumol, and Oates in 1988. The creation of a carbon certificate is an attempt to put price to air pollution. Within the academic literature, there are three types of negotiable emission certificate systems: the environmental permit system (which works based on exposure to pollution at the reception point of this), the emission permit system (which works based on emission sources) and the pollution compensation system (which combines the characteristics of the previous two). There are several ways to regulate the commercialization of certificates, highlighting in particular: the policies of compensation (policy compensation) bubble policy (the bubble policy), the net emission policy (the compensation policy) and the clearing house emissions (bank issues) [1].

The Environmental Protection Agency (EPA) established the compensation policy in the 1980s. These policies can be installed in areas where air quality does not meet environmental standards, as new pollution issues are at least offset by a reduction in the sources of existing pollution emission. Instead of imposing a strict zoning law, preventing the spreading of the actions in the area, the entry of new companies is allowed, any time when the quality of the local environment is not affected. The policy or the net network emission, allows companies to promote internal restructuring if necessary, given the condition that the net increase in emissions, the total of certified emissions with discounts that can be allowed, is below a pre-established limit. The clearinghouse, finally, allows companies to accumulate licenses for use in compensation, bubble and compensation policies or sell them to third parties [1], [2].

The emission reduction credit trading system provides companies with an incentive to negotiate their permits, so they have less means to reduce local emissions, becoming buyers of certificates and vice versa. An important program of control of GHG emissions through the trade of certificates was created in the 70s in the USA, the Emissions Trading Program. This program was designed to offer greater flexibility to companies affected by the Clean Air Act. Any company that could reduce the emissions of a certain pollutant below the required levels could offer reduced emissions of certificates to companies that did not meet their objectives. In this system, if companies issue above the stipulated amount they will receive a fine of US \$ 2,000 per ton of SO<sub>2</sub> more. Each year, the EPA holds 2.24% of the rights and auctions outside of the Chicago Stock Exchange, along with the permits provided by the companies themselves. The program is meeting its initial objectives, and according to the EPA, the estimated emissions of sulfur dioxide were reduced by 30% in 2003 [4], [2], [3].

A differentiated fact was that this market generates benefits for the big reducers and negotiators. However, the fact that the market did not assume a purely speculative profile, and to characterize itself as an environmental instrument, the rates began to focus on pollutants. This innovative program has allowed international trade and has added two separate instruments, quotas and permits [3].

Today, the US adopts various regional initiatives with particular objectives and rules. In California, for example, and seven other states of the Western United States. With the new Obama administration, in contrast to its predecessor, although it has not yet ratified the Kyoto Protocol, the US government has introduced more flexible measurement levels to reduce emissions. The global carbon markets currently mark some basic guidelines common to all, with the support of these theoretical concepts conceived long before the creation of the Kyoto Protocol [5].

<sup>1</sup>Carbon credits, carbon certificate, emission reduction certificate is the nomenclature used in this work to designate, in general, the certificates resulting from the emission of CO<sub>2</sub>e reductions, which implies certified emissions reductions (CERs), the Development Mechanism Clean (CDM) and other emissions reduction certificates resulting from other markets.

Currently, a single carbon market is not conceived, with a definition of only one basic product, for only one contract. What is commonly called the "carbon market" is a sum of various transactions, through which the volumes of GHG emission reductions are sold, which differ in relation to size, form and regulation. .

These operations can be classified in the ones that comply with Kyoto Protocol and the ones that do not. In other words, the ones in which the carbon credits comply with the parameters imposed by the Protocol or not. The information regarding this market is limited and difficult to measure because there is no clearing house for transactions, and not the mandatory publication of prices and negotiations. Some of the most relevant

organizations participating in the global carbon market are: Brazilian Mercantile & Futures Exchange, Bovespa (Brazil), the World Bank, Chicago Climate Exchange, United Kingdom ETS, EU ETS, CERUPT [6].

#### **Brazilian Mercantile & Futures Exchange - BM&F / Bovespa.**

Thinking about the progress of this market, the BM & F, in collaboration with the Ministry of Development, Industry and Foreign Trade and the Getulio Vargas Foundation, organizes the Brazilian Market for Emissions Reduction (MBRE). It constitute a set of regulations, institutions, systems, registries and negotiation project centers that are being implemented in Brazil, in order to stimulate the development of CDM projects and to give greater transparency to the environmental market. For the members of the present BM&F market, they created the CDM project bank. This project is available online at the BM&F website since the end of 2005. The BM&F project database is an electronic system, which records the information that is related to the CDM projects that have already been validated or are still in the design phase. In addition to this, investors pre-selected by BM&F can reveal their intention to buy/sell certificates that will be generated by CDM projects, and also provide loans through auctions. This was the first change in the world to make an auction with claims arising from a Brazilian CDM project, the Bandeirantes landfill [7].

#### **The World Bank.**

The World Bank, actively participates in the carbon market through its funds (mainly fundraising), financing emission reduction projects, in this manner developing countries can employ this resource. Its main funds related to the carbon market are: The Prototype Carbon Fund (PCF), The Netherlands Clean Development Fund; The Italian Carbon Fund, the Biocarbon Fund, the Danish Carbon Fund (World Bank 2010). These funds are public or public/private, with the guarantee of the World Bank. They buy emission reduction projects in developing countries and economies in transition [7].

#### **Chicago Climate Exchange (CCX).**

The Chicago Climate Exchange promotes an electronic commerce negotiation in relation to the reduction of carbon emissions, since December 2003. The CCX is the result of the active cooperation of its members, in the reduction of GHG emissions. They made a voluntary agreement with each other with the elementary rules of reduction and specific patterns of behavior. This is the result of an association of companies from various sectors such as chemical, paper and automotive. They anticipated the implementation of the Kyoto Protocol, and formed this exchange in Chicago that aims to make trade in credit carbon. The negotiations that took place in CCX do not fully follow the standards proposed by the Kyoto Protocol on account of less stringent compliance targets were set. Along the lines of CCX, European Climate Change (ECE) is also negotiating carbon credits. The Chicago Board of Trade launched the ECE, in 2005. Since 2006, along with the CCX was acquired by Climate Change PLC, a company that is part of the London Stock Exchange. Another of the certificates of reduction of the existing negotiation grant pertain to Montreal Climate Change, a joint venture with CCX [6].

#### **Other Markets.**

Other markets that stand out in the field are the United Kingdom. On March 11 and 12, 2002, the Government of the United Kingdom launched its national carbon market (UK Emissions Trading Scheme - ETS United Kingdom), through an auction of 4,028,176 tCO<sub>2</sub>e. Thirty-four companies participated in the auction, with the task of complying with the proposed reductions. Companies can negotiate emission rights among themselves, in order to achieve the established goals [18], [6], [3].

Another market in the same marketing delineation is the UK ETS or Europeu, EU Trade Emissions Scheme - EU ETS, which became operational in January 2005. The first phase of the reduction of compliance is 2005- 2007 and the second one is 2008-2012, coinciding with the first phase of the Kyoto Protocol (DEFRA 2005, ECOSYSTEM of 2008). This is the largest global carbon market, reaching a volume of US \$ 53 billion in 2007, doubling the amount reported in 2006 of US \$ 24 billion [18].

In the month of November 2004, an important fact has contributed to the expansion of the demand for certificates related to CDM projects. The Commission in charge of the EU ETS made a Policy connection (Linking Directive), which is a regulation that determines the relationship between the EU ETS and the Kyoto Protocol. The Linking Directive allows the entities included in the issuance of EU Trade Scheme through CDM certificates, with the firm intention of fulfilling the reduction responsibilities from 2005. This fact has caused European companies to have a greater interest in the purchase of CERs, therefore, comply with the reduction responsibilities [17],

#### **Voluntary Market**

In a system framed by the volunteer, on the other hand, credit trade occurs on an optional basis. The spaces of the two markets are significantly behind schedule. In 2008, 119,000 Million US Dollars (US \$) were

traded on the regulated market, and 704 Million US Dollars (Hamilton et al., 2009) on the voluntary market. In general, the projects exposed to a smaller scale in the states or advanced countries, the voluntary market is projected more interesting than the regulated one. Due to CDM market is composed of very complex components and procedures to carry out the project registries. This exempt the majority of projects, forestry, agriculture and Reduction of Emissions originating from Deforestation and Forest Degradation [8].

The voluntary market has gained relevance for forestry and agricultural projects. Verified credits reduction for Carbon Emissions are obtained especially by the private sector. Corporate Social Responsibility (CSR) and public relations are among the most common motivations for the purchase of carbon credits. Other options are considered, such as certification, reputation and positive environmental and social effects. Some markets provide their customers with neutral carbon emissions (eg, British Airways offers carbon neutral flights and Morgan Stanley provides the equivalent amount of carbon credits). The private sector can buy carbon credits directly from companies, (eg, EcoSecurities) or from carbon funds (eg, World Bank BioCarbon Fund).

### **Analytical Hierarchical Processes (AHP)**

The Hierarchical Analysis Process, developed by Thomas L. Saaty (The Analytical Hierarchy Process, 1980) is designed to solve complex multi-criteria problems. The process requires the decision maker to provide subjective evaluations regarding the relative importance of each of the criteria and then specify their preference with respect to each of the decision alternatives and for each criterion. The result of the AHP is a hierarchy with priorities that show the global preference for each of the decision alternatives .

In an environment of certainty, the AHP provides the possibility of including quantitative data related to decision alternatives. The advantage of the AHP is that it also allows incorporating qualitative aspects that tend to be left out of the analysis due to their complexity to be measured, but which may be relevant in some cases. The AHP, through the construction of a hierarchical model, allows in an efficient and graphic way to organize information about a problem, break it down and analyze it in parts, visualize the effects of changes in levels and synthesize. The AHP is about breaking down a problem and then merging all the solutions of the subproblems into a conclusion

The AHP is based on:

- The structuring of the hierarchical model (representation of the problem by identifying the goal, criteria, sub-criteria and alternatives).
- Prioritization of the elements of the hierarchical model.
- Binary comparisons between the elements.
- Evaluation of the elements by assigning "weights".
- Ranking of alternatives according to the given weights.
- Synthesis.
- Sensitivity analysis.

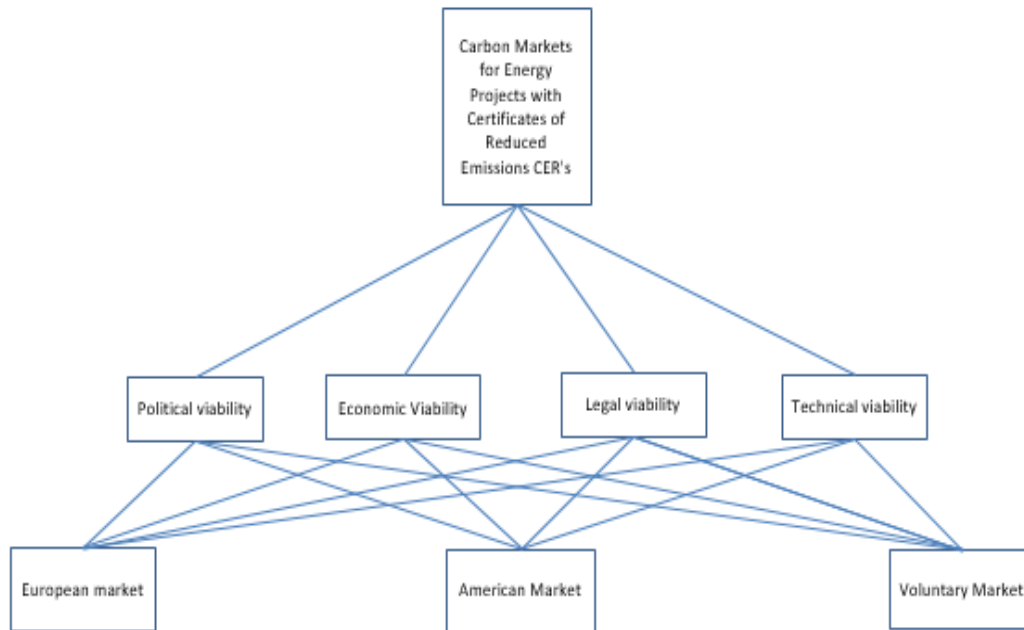
The AHP is a methodological tool that has been applied in several countries to incorporate the preferences of factors involved in a conflict and/or participatory decision-making process. Some of the advantages of the AHP over other methods of Multicriteria Decision are:

<sup>2</sup>The AHP hierarchical analysis process as a tool for decision making in the selection of suppliers, Toskano Urtado, Gerard Bruno, 1990.

<sup>3</sup>Thomas L. Saaty. The Analytic hierarchical process, J Wiley, New York, 1980.

- Present a mathematical support.
- Allow to apportion and analyze a problem by parts.
- Allow to measure quantitative and qualitative criteria through a common scale.
- Include the participation of different people or groups of interest and generate a consensus.
- Allow to verify the consistency index and make the corrections, if applicable.
- Generate a synthesis and give the possibility of performing sensitivity analyzes.
- It is easy to use and allow your solution to be supplemented with mathematical optimization methods.

### III. Analytical Framework

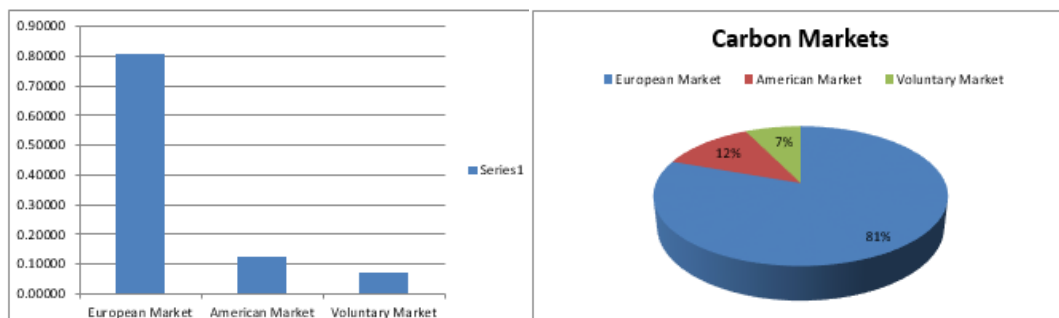


**Figure 1:** Hierarchical Tree of Decisions to Identify carbon markets for energy projects with CER's, own elaboration, 2017.

Applying the Multicriteria theory (MMCC) of Hierarchical Analysis of the AHP. In level 1, the objective is to look for Carbon Markets for Energy Projects with Reduced Emission Certificates, it is verified that it obtains a 4x4 matrix in level 2 (criterion) and a 3x3 matrix in level 3 (alternatives), (see fig.1). Regarding level 2, it is found that the 4x4 matrix has a consistency ratio (CR) of 0.0897, random inconsistency index of 0.9,  $\lambda_{max}$  of 4.24, for some order weights; Political Viability 0.1539, Economic Viability 0.6830, Legal Viability 0.0702, Technical Viability 0.0929. The consistency ratio (CR) is less than 0.10, therefore the matrix has a reasonable consistency and is valid. Regarding level 3, it is verified that the 3x3 matrix obtained and compared with the alternatives of each one of the criteria; Criteria Political viability, the consistency ratio (CR) of 0.0952; Economic Viability, consistency ratio (CR) of 0.095; Legal Viability, consistency ratio (CR) of 0.0639, Technical feasibility consistency ratio (RC) of 0.630. The consistency ratio (RC) is less than 0.10, so the matrix has a reasonable consistency and is valid .

Once the consistency ratios of the criteria matrix and the matrix of alternatives have been demonstrated and they are within the admissible parameters. Procedures to make the corresponding considerations with their corresponding weights are applied. It is possible to observed that among the alternatives proposals to evaluate in which market the CER's commercialization is more convenient; European Market (81%); American Market (12%); Voluntary Market (7%), (see fig.2).

<sup>4</sup>Thomas L. Saaty. The Analytic hieratical process, J Wiley, New York, 1980.

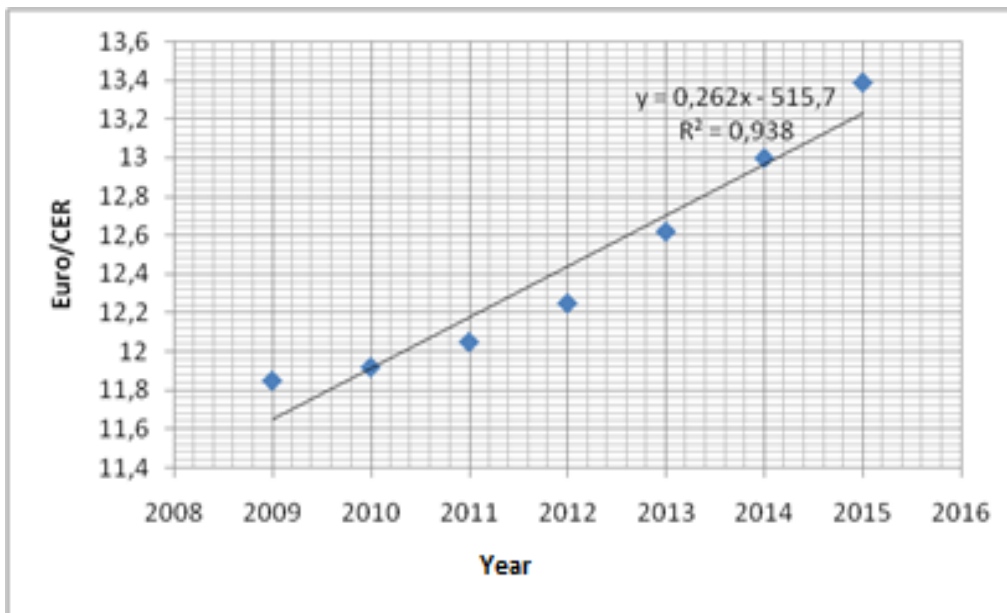


**Figure 2:** Results of the evaluation where the objective is to find the most favorable Carbon Market for the sale of CER's, own elaboration, 2017.

**Table I:** Price forecast CER period (2009-2015). Source [14],2017.

Year	2009	2010	2011	2012	2013	2014	2015
Price (€/CER)	11,85	11,92	12,05	12,25	12,62	13	13,39

The correlation that exists between the years, in which the sale of the CERs was in effect in the European Market, shows a linear behavior with a correlation of 93.8%. To calculate the sales prices of the CERs for the following years (2016-2026), the regression line will be used assuming a linear behavior until the rules are clear in the Carbon Market (See Fig. 3). These prices could be affected after 2020 and not show a linear behavior. Moreover, taking into account what was resolved in COP21, with the green funds coming into effect, although the rules for disbursement are still unclear. However, the entry into force would cause the reactivation of the carbon market and with it a shot in the sales prices of the CERs independent of the mechanism used to certify. It is very likely that the mitigation mechanism approved after the year 2020, in force is very similar to the CDM or at most a modification of it that was in force, but with the proposal of the Coase theorem applied to the mitigation mechanism to give it more dynamism.



**Figure 3:** Line of Regression for the calculation of the sale of the CER's period (2009-2026), own elaboration, (2016).

The proposed cash flow (see Table II) corresponds to the minimum and maximum initial costs corresponding to the negotiation of an amount of 67,834 CERs. The negotiations through the CDM begin in 2018 for a period of 8 years and the certification with the income is considered obtained from the year 2019. These investment costs correspond only to the CDM cycle, it does not consider the investment in works. They were calculated for an electricity generation system using renewable resources (wind energy), in which average annual wind speed of 7m / s, a plant factor of 25%, a total annual energy amount of 100,574 MWh / year. Taking as baseline a combined-cycle thermal power plant (natural gas + diesel type 2) with an emission factor of 0.766 TnCO<sub>2</sub> / MWh. As a result is obtained 67,834 TnCO<sub>2</sub>, that are no longer emitted into the atmosphere. Considering that 1 tree absorbs 0.7TnCO<sub>2</sub> would prevent the reforestation of 96,905 trees, to be CO<sub>2</sub> sinks and thinking over the useful life of the generation system the amount of carbon dioxide that would be stopping releasing would be 1,356 .677 TnCO<sub>2</sub>, for a period of 20 years. So the cash flow of the CDM project, having in mind the initial costs, would be as follows.

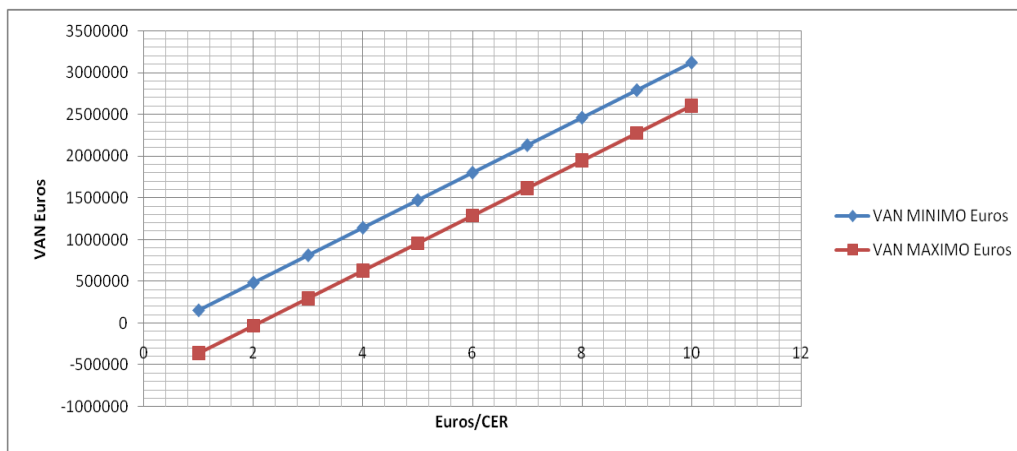
**Table II:** Cash Flow CDM Energy Project With 67,834 CER, Own Elaboration, 2017.

YEAR	2018	2019	2020	2021	2022	2023	2024	2025	2026
EUROS/CER	34,00	14,27	14,53	14,79	15,05	15,32	15,58	15,84	16,1
EUROS INGRES	0	967.989	985.626	1.003.262	1.020.899	1.038.234	1.056.851	1.074.468	1.092.125
MINIMUM COSTS	80.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
MAX COSTS	340.000	115.000	115.000	115.000	115.000	115.000	115.000	115.000	115.000
MINIMUM CASH FLOW	-80.000	947.989	965.626	983.262	1.000.899	1.018.234	1.036.851	1.054.468	1.072.125
MAX CASH FLOW	-340.000	852.989	870.626	888.262	905.899	924.234	941.851	959.468	977.125

NPV MINIMUM COSTS	4.783.284,81€	RATE	10%	TIR	138,7%
NPV MAX COSTS	4.267.995,81€	RATE	10%	TIR	61,1%

These numbers give an idea of how small the costs of the CDM process are compared with the income that can be obtained. For the analysis of the proposed project using, renewable resources (wind energy), it will be taken as income obtained from the certification 3US\$/CER for the scenarios raised in the economic considerations. This is the lowest value that can be obtained as income, product of the certification to not have a NPV < 0, in the cash flow of the CDM Cycle, for the amount of the proposed 67,834 CERs, maintaining an interest rate of 10%, for the registration of the project (see fig.4).



**Figure 4:** Minimum Cash Flow And Maximum Allowable For Project CDM Type 67,834 CER, Own Elaboration, 2017.

#### IV. Economic Evaluation

Assuming the considerations that have been made clear in the article: Wind speed 7m/s at a height above ground level of 80m; Installed Power (46MWe) and the number of wind turbines (20 of 2.3MWe). A total investment of approximately US \$ 105,017,111 is estimated. Considering an own contribution of the enterprise of about US \$ 31,505,133, external financing would be required. about US \$ 73,511,978. In the amount of the investments mentioned above, the benefits granted by Law No. 60/90 on the promotion of investments have been considered. For this type of projects based on renewable energies and energy efficiency there are funds with very low interest rates and flexible and long payment terms. The economic analysis shows that the investment needed to start up the 46MWe wind farm would be amortized by the sale of energy under a sale price of US\$ 120/MWh, equivalent to US \$ 12,068,931 per year. [11].

On the other hand, in the case of a renewable energy project, it could benefit from the CDM. Having this point as background and the economic viability of the CERs through the CDM seen above. Furthermore, that the lowest price that could be obtained from the sale of CERs is US \$3/CER for the viability of the CER

through of this mechanism. In addition, if a baseline thermal plant hybridized with (natural gas + diesel type 2) of the same power (46MWe), emission factor of 0,766 TCO<sub>2</sub>/MWh, of the energy generated as equivalent to the amount of carbon dioxide is considered as baseline Carbon not emitted into the atmosphere. This is equivalent to 67,834 CER and could generate an additional annual income of about US\$2 03,501. Additionally, in the international market for projects of this type subsidies are considered by the state as incentives of around US\$3/MWh, which represents an additional income of some US\$ 301,723. It could eventually amortize the investment in a reasonable time, totaling in this way an annual income of US \$ 12,574,156. For a plant factor of 25%, investments could be amortized over a period of 5 years, resulting in an IRR of 19.9% and a NPV of US \$ 93,646,181. This analysis shows the feasibility of the project [16], [11].

## V. Conclusions

With the results obtained it is verified that it is feasible to sell the Certificates of Reduced Emissions (CER's) of an electric generation system. Using non-conventional energy from renewable resources (Wind Energy) and the way that these help in the amortization of large-scale energy projects. As a result, the sale price of energy gain more competitively with the other sources of power generation, helping in the diversification of the Energy Matrix. The use of the Hierarchical Analysis Model Tool (AHP) is fundamental to analyze the most suitable Carbon Market for Paraguay. Under the criteria stated at the beginning of the article and given the lack of experience of the Country in this type of transactions but the great potential in renewable resources. It is very likely that after 2020, the rules in the Carbon Market will be more flexible and less bureaucratic and in this way accelerate the certification of energy projects. It can be concluded that the Clean Development Mechanism is a fair mechanism for both the seller and the buyer, bearing in mind that it guarantees both parties the benefit and the main winner is the environment. As global awareness of the effects of Greenhouse Gases (GHG) becomes more widespread, there will be greater awareness of the effects of climate change on the daily life of human beings.

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