

# The Clean Development Mechanism as a Means to Assess the Kyoto Protocol in Colombia

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**Abstract** - Funding Mechanisms to develop infrastructure projects should be both profitable and sustainable. For this reason, the Clean Development Mechanism must have a pivotal role for increasing the offer of sustainable projects as a means to assess the Kyoto Protocol's efficacy through the diagnosis of projects developed in Colombia. In this paper, we analyzed 129 projects that received financing through carbon credits in their first accreditation period (between 2005 and 2015) as an initiative to mitigate climate change and increase of the power offer. We concluded that the hydropower projects and more specifically, the Antioquia region's hydro projects have obtained major sustainable financing. This is largely due to the great capacity for generating power and special geographical conditions, which encourage the development of electric projects. In addition, Colombia should also improve the synergy among the development of infrastructure projects, the Clean Development Mechanism, and the Kyoto Protocol. This will allow to develop new sustainable projects based on carbon economy, considering impacts of climate change and the integrated assessment of climate change. This paper is expected to contribute to encouraging capital markets and private participation for developing sustainable projects in the different sectors, particularly the social, where private investors need to have more financial products. This will allow to mitigate climate change and increase the bid of securities in the Colombian market capital.

**Keywords:** Carbon economics, Climate change, Clean Development Mechanism (CDM), Kyoto protocol.

## 1. Introduction

It has widely been reported that Climate Change is a consequence of the greenhouse effect gases (GHG) which are released into the planet's atmosphere; it is in fact, one of the most important problems our civilization faces in the present. Great concern on weather alterations has become a common discussion and research topic within multiple disciplines. This has led to analysing the degree of responsibility that countries have on this subject. It has been determined that there are sectors with a higher level of incumbency in this phenomenon such as the industrial sector and the commercial sector. [1] - [3].

In this scenario, the Kyoto Protocol plays an important role. In order to achieve its objective, various measures have

been implemented to mitigate emissions; they have primarily been implemented in the developing countries considering the importance of sustainable development [4]. The main form in which such measures have been implemented is under the form of projects. The industrialized nations can fund these kinds of projects leading to reduce the emissions of greenhouse gases. An example of this is the trading of emission reduction certificates also called carbon credits. Thus, we have a scenario aiming to the development of projects according to the new environmental challenges; this represents an opportunity for the developing countries to implement a wide range of projects under the Kyoto Protocol mechanisms, particularly the Clean Development Mechanism (CDM).

Additionally, the Kyoto Protocol has encouraged the development of the CDM aiming at two goals: firstly, to provide support to the nations included in Annex I (list of developed nations and economies in market transition that signed the Kyoto Protocol) so they can meet their commitments with the Kyoto Protocol. In second place, it looks at encouraging sustainability in the developing nations by means of the implementation of those projects. Thanks to the transmission of substantial technologies in this field from the most developed nations to the developing ones, significant economic and environmental benefits will arise. For instance, we can mention the growing trade of carbon credits (CER). In fact, the Certified Emission Reductions that will be generated through the CDM can be allocated to the projects which lead to reduce GHG emissions. It means that these credits can be traded to industrialized actors. CER represent allowances to those actors that will authorising them to emit more GHG than the legal amount granted; indeed, CERs can be negotiated in the stock markets [5], [6].

Among the topics that have been studied by diverse research groups and later published in literature, there is the issue of using RE systems in CDM projects rather than the traditional power systems. Additionally, further discussions have also approached the consequences that CDM projects bring to communities in terms of their economic development and the environmental repercussions. What the literature review shows is a growing occurrence of the fact that in remote areas, emission reductions frequently happen when implementing RE projects [7]–[12].

As a consequence of the need for meeting the commitments signed by the Latin American countries on implementing the Kyoto Protocol, this region has undoubtedly turned into a CDM project leading region. This is mainly due to the support that these governments (through special commissions and specialists) have given to encouraging this type of projects. Among the various types of CDM projects, hydroelectric power plants outstand [13]. In particular, Colombia has a diverse energy mix that provides great opportunities for participation in the CDM, due to its natural sources and special topographical conditions for the implementation of alternative energy projects.

This paper examines how the CDM has encouraged the development of power projects in Colombia; considering the market carbons and the reductions of greenhouse gases. The above mentioned (plus taking into account that countries in the European Union and countries from Asian regions such as Japan present high demands for meeting their domestic emission reduction rates) create a suitable setting for countries like Colombia to become a lead player in the CER global context. In fact, Colombia's large hydropower capacity can lead the nation to join the international carbon market by trading its CER with the industrialized nations.

## 2. The Carbon Market and its Application

The carbon credits market works as follows: the member States listed in Annex I of Kyoto Protocol often develop

National Allocation Plans (NAP); according to them, emission limits are set to their companies. Within these limits, businesses can buy and sell rights according to their needs and at the end of the year, they return a quantity of rights equivalent to their emissions. In this way, emissions are reduced where it is most profitable [14].

Considering the above, it is logical that this market is highly attractive to developing countries. Indeed, industrialized countries generally have more efficient technologies, which is why the opportunity cost of reducing GEG emissions in these countries is greater than the cost of such investments in developing countries. Therefore, this market has created an important number of opportunities for the developing countries like Colombia. It allows to develop CDM projects which originate CER and from them, additional profit can be made. Particular investment projects could also be derived from them as well as access to eco-friendly technologies.

### 2.1. CDM Project Cycle

Below, there is the general model of CDM's economic assessment described. Any project seeking for accreditation as a CDM should follow the same criteria and complete the steps to be able to negotiate their quantified reductions of greenhouse gases in the carbon market. This process is commonly called the CDM project cycle [15], as it is shown in Figure 1.

Initially, it is necessary to establish if the project has the potential to be a CDM one; that can later lead to the trading of CER. It is relevant to mention that CERs equal a ton of reduced CO<sub>2</sub> certified by the CDM Executive Board. Therefore, they legal to be used under the Kyoto Protocol, by the nations that signed GHG reduction compromises [16].

Transferring to the community part of the revenue from the sale of the CER generates development and welfare in the area, facilitates the process of approval and negotiation of licenses and reduces credit risk of the country for projects. The sale of certified emission reduction of carbon dioxide represents a good opportunity for income and social benefits for Colombia, especially if it is used with small and medium hydropower plants [17].

### 2.2 Certified Emission Reductions (CER)

These are documents through which the reduction of GHG emissions are certified. It is through either the mitigation or capture of carbon dioxide; it is based on one ton of carbon dioxide as measuring unit, so each certificate is equivalent to this amount [18]. These Certificates, also known as Carbon Credits are exclusively issued by the Executive Board of the United Nations. For our case, CDM projects, they are issued during the last phase of the CDM cycle and are transferable negotiable documents in the carbon market.

"A CER is a unit issued in consonance with the provisions of Article 12 in Kyoto Protocol. Also, according to other relevant provisions in the modalities and procedures of the

Clean Development Mechanism. It equals a metric ton of carbon dioxide or its equivalent calculated according to the global warming potential defined by Decision 2/CP.3 or as subsequently established in accordance with the provisions of Article 5 in Kyoto Protocol"

(Article 5 KP).

The following constitute CERs' features:

- a) Uniformity: CERs equal one metric ton of carbon dioxide, despite of the project, sector, activity or parties involved in the generation of the CER.
- b) Transferability: All CERs can be transferred.

c) Valuing: All CERs have a commercial value because of the primary and secondary markets derived from the Kyoto Protocol.

d) No Expiration: There is no expiration period; they can be used whenever they are required.

Paraphrasing the previous paragraphs, we can state that CERs correspond to the right to produce a certain quantity of GHG into the atmosphere in compliance with the Kyoto Protocol [1].

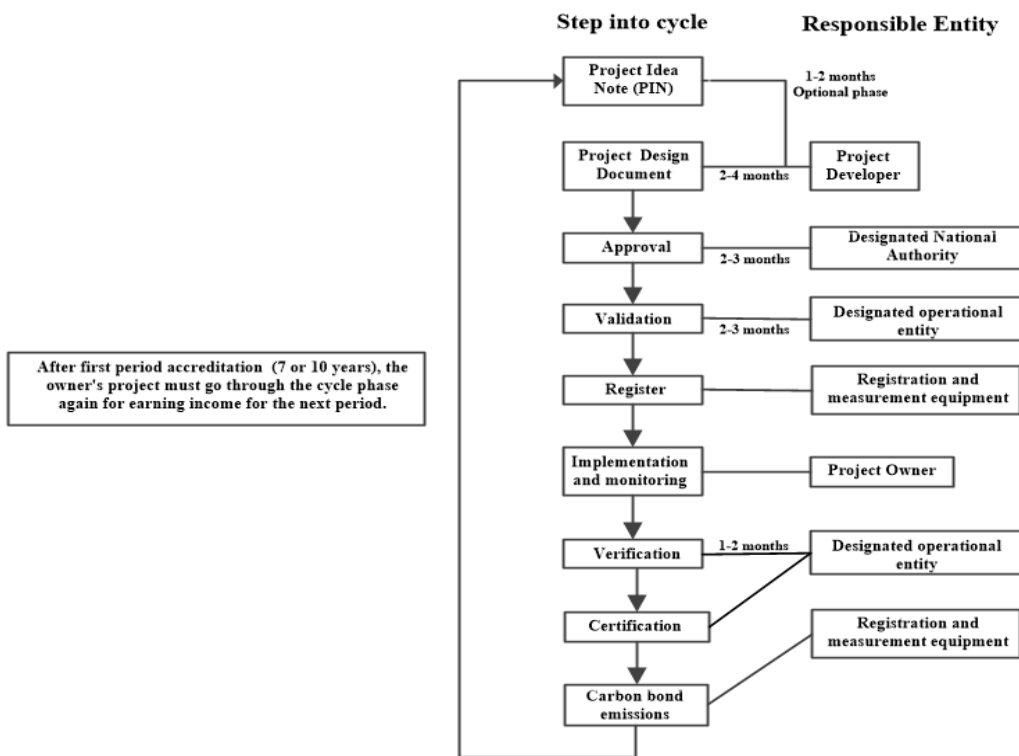


Fig. 1. CDM Project Cycle [1]

### 2.3 International Financing Opportunities

Access to international resources to complement the development of national programs enables governments to increase the scope of the programs developed in priority policy areas. In this sense, there is an important set of institutions both, multilateral and governmentally funded which provide capital; they are usually repayable contributions for the development of action on climate change [19]. Some of those institutions are briefly presented:

- *Japan Bank for International Cooperation Bank*: A financial institution of the Government of Japan to develop financing programs and technical assistance to third countries, providing resources as loan repayable contributions.

- *Inter-American Development Bank - Environment*: This institution supports the efforts of the countries of the American continent to achieve environmental goals. On climate change, it finances greenhouse gas emission mitigation programs.

- *Fund of the United Nations for Global Environment Facility (GEF)*: This is an independent financial organization which offers repayable contributions for the projects that develop and promote environmental benefits and improve the quality of living of communities.

- *World Bank - Carbon Finance*: The World Bank has four funds for carbon finance activities: Carbon Prototype Fund (CPF), Netherlands Clean Development Facility

(NCDF), Community Development Carbon Fund and Bio Carbon Fund (Bio CF).

- *Offer to Purchase Certified Emission Reduction - CERUPT (Certified Emission Reduction Unit Procurement Tender)*: The government of the Netherlands and the CPF are pioneers in the implementation of CDM. In 2001, an auction program (CERUPT) is established. It is administered by the governmental agency SENTER to acquire CDM projects directly. This process culminated in late 2002 with eighteen tCO<sub>2</sub>e 16'550,736 contracts amounting to about USD \$ 89 million and an average price of 4.7 euros per tCO<sub>2</sub>e. At present, the Dutch government no longer directly purchases CDM emission reductions but it purchases through multilateral and private banks and memoranda of understanding with countries in the developing world.

- *MGM International*: An international intermediary company specialized in the acquisition of CERs in Latin America with the support of Japanese companies, not only to acquire CERs, but also (if necessary) to provide capital for development projects.

- *Latin American Carbon Program (LACP)*: This is an initiative by the Andean Development Corporation. Its main objective is to contribute to the establishment of carbon market instruments, define the necessary financial mechanisms and promote the business and the productive sectors engagement.

#### 2.4 Corpus of the Colombian national regulatory framework

In 1994, Colombia adopted the Kyoto Protocol through Act 164, aiming at finding alternatives to address climate change issues. Endorsing this instrument involves to meet its commitments, in accordance with the common principles but taking into account the priority of national development. In 2000, Colombia ratified the Kyoto Protocol through Act 629. That year, the Ministry of Environment, Housing and Territorial Development (Ministry of Environment) designed a National Strategy Study for the implementation of the CDM in Colombia. Its objective was to evaluate the country's potential facing the new market, to identify the constraints and limitations, to develop strategies to overcome them and to promote the potential benefits for the country [20].

Later in 2002, the Ministry of Environment and the National Planning Department developed the "Guidelines for Climate Change Policy", which outlined the main strategies for mitigation and adaptation to the phenomenon in the context of the UNFCCC, the Kyoto Protocol and the First National Communication on Climate Change issued in 2001 IDEAM. In this same year, the Colombian Office for the Mitigation of Climate Change was created; it was designed to be the promoting entity of all CDM projects. It aims at promoting the consolidation of competitive and efficiently

economic projects that could be traded on the market reducing global CO<sub>2</sub> emissions.

Additionally, in 2003, the "National Strategy for the sale of environmental services to mitigate the climate change," CONPES 3242 was created. It established the essential guidelines for the introduction of CDM projects. In 2004, judicial decisions 0453 and 0454 were issued. The first one designated the Ministry of Environment as the national CDM authority (Consular Note DM / VAM / CAA 19335 of the Ministry of Foreign Affairs addressed to the UNFCCC) and adopted the Kyoto Protocol's principles, requirements and criteria. It also established the procedures for approving national projects on GEG reductions eligible for the CDM. The second decision regulates the functioning of the Sectoral Technical Committee for Climate Change Mitigation of the National Environmental Council. Among the functions of the National Environmental Council, there is to create inter-sectoral technical committees involving technical officials for coordination and monitoring tasks [19].

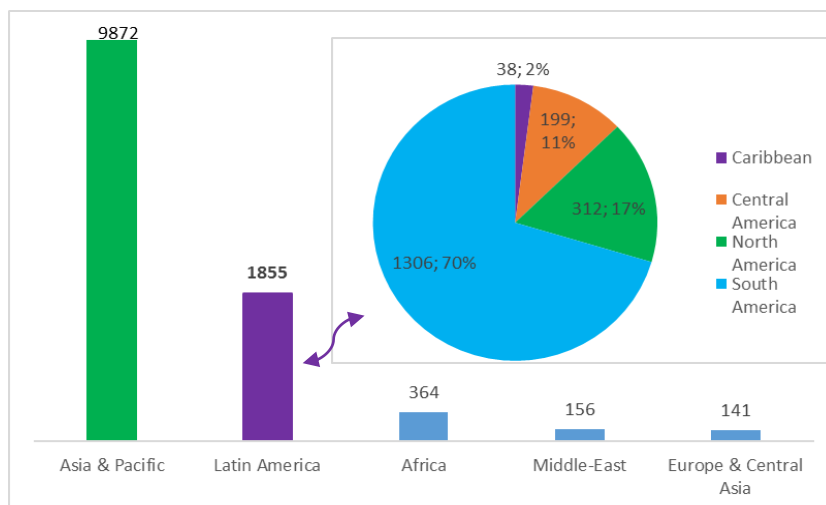
These procedures are complemented by decisions 2733 and 2734, December 29, 2010. They adopt the requirements and evidence of contribution to sustainable development in the country. They establish the procedure for national approval of programs of activities (PoA) under the CDM and the coordinating entities.

In general, the regulatory framework of each country belonging to the Kyoto Protocol Non Annex I (developing countries) establishes the regulatory foundations of national approval processes of CDM projects. It also defines the eligibility based on the each CDM project contribution to sustainable development of the country, according to their priorities and strategies to mitigate and adapt to climate change [20].

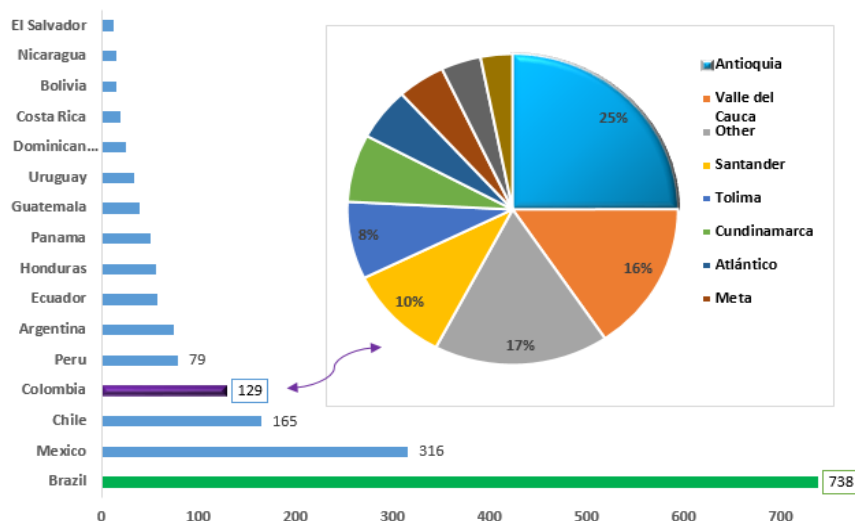
### 3. Presentation and Discussion of Results

The countries in the Latin American region have turned into the main providers of CDM projects in the world; even more important than Asian countries since they have devoted efforts to alleviate climate change led by the developed countries. This fact has led some governments in the region to design support policies as a result of the implementation of the Kyoto Protocol; in addition, they have CDM approval systems that work favorably highlighting the presence of senior business executives in institutions promoting CDM; this has led to greater cooperation between industries and these institutions.

It is then a fact that CDM projects possess a significant capacity for promoting sustainably development in the Latin American region. As well, renewable energy projects offer greater sustainable development benefits due to the fact that they produce clean energy, to their contribution to reducing power dependence and increase safety; this often creates jobs so unemployment rates can be also reduced [14].



**Fig. 2.** CDM projects registered worldwide



**Fig. 3.** Latin American Projects registered in the UNFCCC

Additionally, research conducted in developing countries present evidence that investing in more efficient technologies, the balanced use of power and substituting traditional fossil fuels with sustainable ones, diminish the emissions of GHG. Likewise, to reduce the greenhouse gases associated with the generation of energy it is necessary to interconnect large amounts of renewable energy to the electricity grid, especially low cost technologies [22]. In this sense, SHP (small hydroelectric plants) represent a source of renewable energy reducing greenhouse gas emissions. It is then possible that the CDM market become a source of opportunities for their development [5], [23].

Another important factor that has helped to conduct the attention of experts towards SHP projects is the negative environmental impacts that have been associated to the use of large hydropower plants. Indeed, SHP projects constitute one of the most efficient, reliable, clean, and largely carbon-free mechanisms in the struggle for reducing GHG emissions (these type of projects produce negligible amounts of greenhouse gases). They also represent flexible, cutting-edge technologies and an inexpensive method to generate electricity [23]–[26].

Until 2016, there are 1855 projects registered in the UNFCCC under CDM in different Latin American countries;

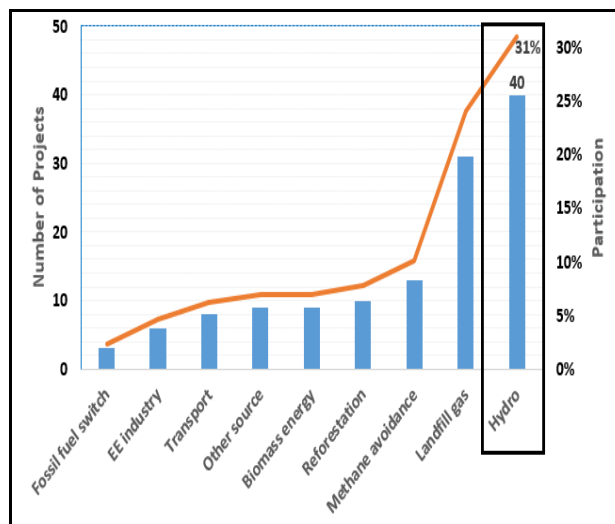
40% of them are located in Brazil and 9% were presented by Colombia. (See Figure 2 and 3). Colombia's project portfolio highlights the implementation of initiatives in Antioquia (25%), in Valle del Cauca (16%) and Santander (10%).

In Colombia, the table below shows how CDM projects are classified.

**Table 1.** CDM projects in Colombia

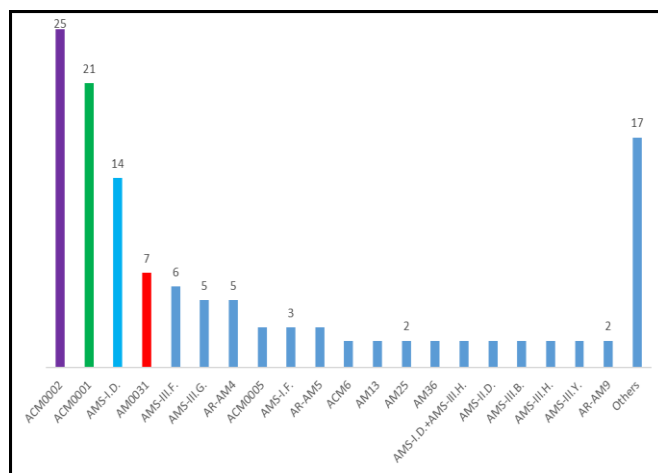
Sector	Description
<b>Mining and energy</b>	Renewable sources projects, fuel switching, technological improvements in thermal generation and reduction of methane leakage in mines and wells
<b>Industrial</b>	Programs for energy efficiency, fuel switching and cogeneration.
<b>Transport</b>	Mode changes, organized urban mass transit systems and fuel switching
<b>Waste</b>	Methane capture in landfills and wastewater treatment plants
<b>Agricultural</b>	Reforestation and afforestation activities

In the Colombian case, the distribution of projects registered under the CDM scenario is predominantly towards renewable energies such as: Hydro (31%) Landfills (24%), Methane avoidance (10%) and Reforestation (7.8%) and together account for 73% of projects reviewed. By analysing 129 research projects, we highlight Spain, Switzerland, the UK and the Netherlands as main buyers of CERs. Moreover, most companies used consulting for the development of CDM projects. The main consultors were MGM International, CAEMA (Andean Centre for Economics in the Environment), Environmental Business and Technologies and Grütter Consulting with 45% of the full participation. It is noteworthy that none of these companies are Colombian.



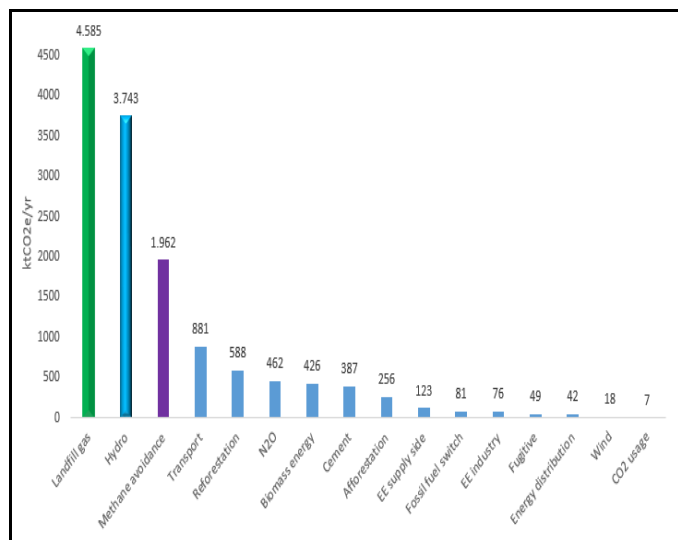
**Fig. 4.** Categories of projects analyzed in Colombia

Figure 5 shows that methods for hydropower (AM0002 and AMS-I.D.) represent as much as a 30% share of all UNFCCC applied methodologies used in Colombian CDM projects whereas landfill projects (ACM0001) represent a 17%. Other activities with more modest participation are related to projects for power cogeneration using biomass energy and replacement of fuel oil with natural gas in power generation.



**Fig. 5.** Methodologies of the Colombian CDM projects analyzed.

By the implementation of these projects in various areas and the application of different methodologies approved by the UNFCCC, Colombia has acquired sufficient knowledge and technological capabilities to develop its own projects throughout the country without actually importing technologies. During the last five years, ktCO<sub>2</sub>e 13,687.21 / yr has been obtained in the first crediting period by projects registered under CDM. More than the 75% of the CERs for Colombia is obtained from the use of renewable technologies such as gas Landfills (33.5%), hydro (27.3%), and Methane avoidance (14.3%) [27].



**Fig. 6.** Renewable technologies of the Colombian CDM projects analyzed.

It is important to ascertain the relevance of the CDM in developing countries like Colombia since it leads to obtaining special benefits from trading CERs and the renewable technology appropriation, which is ecofriendly.

Every day, there is a greater awareness of the economic, social and environmental benefits generated by carbon markets under the CDM [28].

#### 4. Conclusions

An advantage of using CDM projects is the fact that they reduce emissions cost-effectively. The economic approach shows that it is more inexpensive to reduce emissions where it is cheaper to do so. The effort that the developed countries should do to modify their domestic industries is greater than if they decided to help the implementation of clean technologies in developing countries. Among the consequences of implementing these projects, we can mention an increase in generating foreign exchange, the transmission of environmentally valuable knowledge, ecological resource management, the reduction of poverty caused by increasing income, the increase on social investment, the reduction of pressure on native forests and the generation of uninterrupted power at lower costs.

As mentioned, Colombia is a country that envisions significant chances of becoming a lead player in global settings due to its high hydropower capacities and the possibility to join the international carbon markets by means of trading Certified Emission Reductions; this is thanks mainly to the domestic demand reduction commitments (mainly signed by the European countries and Japan) which help strengthening this market. Thanks to geographical conditions, Antioquia's region is the leader in the development of sustainable projects [29]. Furthermore, there are important opportunities for the economic development of the region and others by means of implementing CDM

projects. Consequently, CDM projects represent an environmental and inexpensive alternative for Colombia; this guarantees not only an income system but also it helps promoting research and development activities related to the power and environmental technology sectors. Finally, CDM projects could be implemented in other sectors such as water infrastructure systems and waste management sectors, where laws have not yet been enacted. Furthermore, future research should involve the combination of financial mechanisms, such as convertible bonds and securitization allowing the arrival of more investors through the Integrated Latin American Market (MILA).

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