

Sustainable Energy in Latin America: Regional Development Through the CDM

E. A. Duque^{1*}, J. D. González^{1,2}, A. Pena³, H. A. Patino³ and J. C. Restrepo¹

¹Institucion Universitaria Esumer. Medellin, Colombia; eduardo.duque@esumer.edu.co,
juan.restrepo43@esumer.edu.co

²Institucion Universitaria Esumer – Universidad Nacional de Colombia, Medellin, Colombia;
jdgonzalez@esumer.edu.co – jdgonza3@unal.edu.co

³Universidad Escuela de Ingenieria de Antioquia, Medellin, Colombia;
pfjapena@eia.edu.co, hector.patino@eia.edu.co

Abstract

Objectives: In this paper, 1100 projects in Latin America are analysed as initiatives to mitigate climate change and increase sustainable energy production. **Methods/Statistical Analysis:** In our analysis, we have imported the data from the available databases about CDM projects. Projects have been grouped by region, country, and type of source. **Findings:** It was concluded that the region's hydro electrical projects have obtained relevant sustainable financing due to the region's rich capacity for generating power and its particular geographical conditions, which encourage the development of sustainable energy projects. However, many political, social and economic obstacles to this were also found. This paper is expected to contribute to the promotion of an alternative energy industry and the private participation in the development of sustainable energy projects in different sectors in the region. **Improvements:** This paper proposes several alternatives that could help improve the synergy among the development of sustainable energy projects, the Clean Development Mechanism (CDM), and the Kyoto Protocol leading to grow new sustainable projects based on carbon economy, considering the impacts on climate change. Financing mechanisms to develop sustainable energy projects should be both profitable and sustainable and this is why the CDM should play an essential role for increasing the offer of sustainable projects as a means to assess the Kyoto Protocol's efficacy.

Keywords: Clean Development Mechanism, Hydro Electrical Projects, Sustainable Energy, Sustainable Development

1. Introduction

“Signing is good, ratifying is better.” French President Hollande’s most relevant quote at the World Climate Change Conference 2015 (WCCC) summarizes part of this paper’s main objectives. The increasing number of environmental abnormalities happening worldwide have become the concern of the industrialized and the developing countries but particularly, the responsibility falls on the actors in the industrial and business sector as the main agents of this change^{1,2}. Being France the first nation to ratify the climate agreement reached in Paris (2015) constitutes a call for the rest of the nations that participated

in this event. That Conference determined that Latin America is one of the world’s most at-risk regions.

Given this scenario, besides the WCCC, the Kyoto Protocol also plays an important role since it has already been endorsed by many nations which have been developing important actions to comply with the commitments signed. In order to achieve Kyoto’s goals, various measures have been implemented to mitigate gas emissions. Such measures have been implemented as projects funded by the industrialized countries to reduce the emission of greenhouse gases. Carbon Credits, also called Certified Emission Reductions (CER), are granted to projects that reduce their greenhouse gas (GHG) emissions and can be

*Author for correspondence

traded to industrialized actors as “permits” to emit more GHG than the authorized quantity and market them in the stock market^{3,4}. This represents an opportunity for nations to implement a wide range of projects under the Kyoto Protocol mechanisms, particularly the Clean Development Mechanism (CDM)⁵.

Taking into account the region's priority for facing this challenge, Latin America has become a relevant supplier of CDM projects in the world thanks to the execution of the Kyoto Protocol mechanisms that support regional governments⁶. This contribution is exerted in the form of CDM project assessment committees and the presence of local experts in institutions promoting CDM projects. Financing mechanisms to develop sustainable energy projects should be both profitable and sustainable and this is why CDM must play an essential role for increasing the offer of sustainable projects as a means to assess the Kyoto Protocol's efficacy.

This paper proposes several alternatives that could help improve the synergy among the development of sustainable energy projects, the clean development mechanism, and the COP 21 agreements leading to build new sustainable projects based on carbon economy, considering the impacts on climate change. This paper is expected to contribute to encouraging the private sector for developing sustainable energy projects in Latin America in different sectors. This paper is structured as follows. The next section provides a description of the Clean Development Mechanism as a tool for increasing sustainable energy projects. Section 3 describes Latin America's hydroelectric potential. Finally, Section 4 provides the main remarks and opportunities for further research.

2. Concept Headings: Renewable Energy and CDM

The purpose of the CDM is to reduce emissions by transferring technologies from the developed countries to the developing countries for a lower marginal cost but with extensive ecological benefits. Although technology transfer is not compulsory for CDM projects, the importance of the technology transfer has long been reinforced in both UNFCCC provisions (Article 4.1; 4.3; 4.5) and in the Kyoto Protocol (Article 10; 11.2)^{1,4,7-9}.

Under the Clean Development Mechanism (CDM), the industrialised countries can achieve some portion of their required greenhouse gas commitments under the

Kyoto Protocol from “credits” generated through lower-cost emission reductions in projects beyond their own borders. Governments, investors and private companies in the industrialised countries can receive credits for reduction projects they carry out in “host/seller” countries¹⁰.

While several proposals to enforce the CDM have emerged in the region, many uncertainties remain on how to create a new, more effective mechanism that can encourage stronger mitigation actions in the developing countries and eliminate bottlenecks and bureaucracy (maintaining the integrity of the emission reduction credits). A major obstacle to design an effective solution is the lack of information flows among the actors involved in the CDM implementation and those involved in international climate policy discussions¹¹. From the findings, strong criticisms on the CDM process being complex, non-transparent and having overly bureaucratic procedures were evidenced. Other major issues that were identified included high transaction costs, no guarantee that the projects would be selected after the complex maze of procedures and the contrast in regional distribution of the selected projects¹².

On the other hand, the access to renewable energy (RE) is pictured as valuable in promoting environmentally benign developments using small community-based CDM projects. In this regard, the CDM has limited its scope and so far, has been unsuccessful in terms of promoting small-scale community developments¹². It can also be mentioned that small-scale community-based rural renewable energy CDM projects can offer suitable alternatives leading to help reducing poverty and bring new income benefits. In addition, such types of projects are able to back the development and execution of RE in distant non-electrified zones encouraging local entrepreneurship.

There is no doubt that CDM projects possess great potential to promote sustainable development while reducing GHG emissions in this region; it can definitely promote low-emission options on the supply side, and energy efficiency on the demand side, as well as more sustainable opportunities in the transportation, forest and agricultural sectors¹³.

2.1 Sustainable Energy Development

According to the US President's Council on Sustainable Development, “Economic growth can and should occur

without damaging the social fabric of a community or harming the environment”¹⁴. In this work, we are focusing on four dimensions of sustainability: namely technical, economic, social and environmental. Figure 1 shows Sustainable Development concepts from the authors.

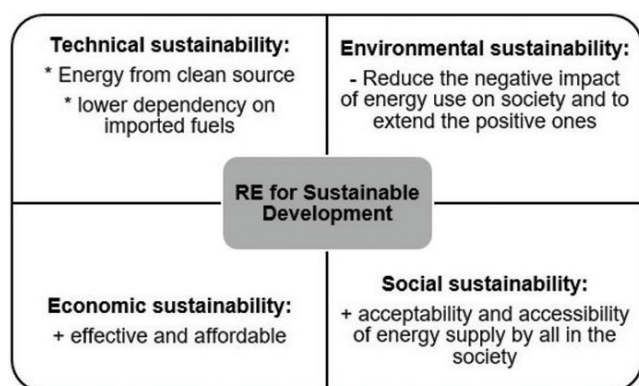


Figure 1. Definition of RE for SD

As stated before, the CDM represents a huge potential to promote sustainable development in Latin American countries. RE offers important sustainable development benefits since it generates clean energy, contributes to energy independence & safety, and it often creates employment opportunities¹⁵.

2.2 Financial Mechanisms for Renewable Energy

The key for developing RE in Latin America lies in having access to funding. This is mainly due to the fact that the initial implementing costs for this type of technology require high investment. In this region, the conventional energy sources can actually be replaced by Renewable Energy Technologies (RET) in order to help the mitigation of environmental damage (caused by those traditional power generation methods). Direct financing, (subsidies, subventions, direct hiring or equity issuance) constitute an efficient instrument to promote RE in the region. Financing support to RE projects is often regarded as a means for obtaining additional socio-economic benefits such as access to power, social development, employment generation and poverty alleviation.

Diverse types of equity investors would engage in such projects. It all depends on the kind of project, the current state of the technology development and the degree of associated risk these projects might represent. Private Equity companies (which usually concentrate on the

later factor and on mature projects) for instance, generally expect a return on their investments between 3 and 5 year-time periods. Infrastructure Funds (waste facilities, highways, railroads etc.) are known for their interest in low-risk projects. It means, longer term investments and, therefore, lower returns. Also, there are Institutional Investors like pension funds, which have an even longer time horizon and larger amounts of money to invest (and demand lower risk levels)¹⁶. It can also be stated that this region's governments should seek for mobilizing RE financing in two comprehensive ways: establishing overarching regulatory and incentive frameworks to shift investments into RE; and by using targeted funding public to overcome specific finance gaps and barriers. Fiscal incentives for RE have been identified in the countries of this region; they include tax exemptions, accelerated depreciation, imports incentives and fiscal stability among others. Within those tax exemptions, there is the income tax, the VAT, the sales tax, the equity tax, local taxes, administrative fees, import tariffs, resources taxation and some others. Exemptions can include reduction or the elimination of certain charges, deductions, tax refunds, fiscal credits or even modifications to payment deadlines. Fiscal exemptions in general, are applied to services, equipment and pre-investment fees related to RE projects as well as power sales tax, and in some cases, carbon credits and other complementary income.

A feed-in-tariff (FIT) is a policy used as a support mechanism to accelerate investment in RET. According to¹⁷ “a feed-in tariff (FIT) is an energy supply policy focused on supporting the development of new RE projects”. Also, tax credits could be applied for the investment, production, or consumption segments of electricity generated by RE. With the same purpose, governments can establish policies aimed at encouraging RE consumption applying tax credits on the purchase and installation of renewable equipment to facilitate the penetration of RE in the market.

Private investors compete on the basis of financial returns, however the highest are mainly found in non-renewable energy production. Due to the fact that in Latin America, the markets are still learning how to competently account for externalities (social and environmental costs incurred by conventional energy production), RE can be economically viable, even if it is not financially viable. To ensure a successful and sustainable future, governments are taking action to encourage and facilitate RE financing. In many developing countries, national policies have

already played a decisive role in shaping RE markets so that financiers will find them attractive¹⁶. RE investors in the developing countries include governments, banks, equity firms, insurance companies, pension funds, industry bodies, clean energy companies, and start-up project developers. In this research, it was found that in Brazil companies are eager for investing in RE, particularly local pension funds and insurance companies.

Finally, it is important to note again that concerning energy supply, the CDM can provide incentives for promoting RE since carbon credits can contribute to the financial attractiveness of these projects. Continuous innovation is definitely a must in order to encourage the implementation of RE by updating the existing technologies, enhancing the technology transfer from the industrialized nations and fostering mass implementation of innovative systems. The above mechanisms are required so that benefits from scale economies are attained, and costs, that often remain high compared to fossil fuels can be decreased¹³.

3. Results and Discussion

It is a fact that Latin America has become a major player in RE sources. This region has experienced a rapid growth and interest in the development of these kinds of energy resources. The high prices of electricity in the region, the increasing demand, the energy safety problems and the exportation potential constitute a promising mix of elements for deploying RE (the recent decrease in some technological costs and the increase in competitiveness are other factors that cannot be ignored). Those features have led the region to be one of the world's major CDM project supplier. This is thanks to governmental support from the commitments signed in the Kyoto's Protocol, the development of easy CDM project assessment and approval systems and the presence of local experts in CDM promoting institutions. Figure 2 shows the region's CDM project participation in the world's context.

Among the 1,100 Latin American projects, Brazil's participation stands out (with the 35%); Mexico and Chile contribute with the 18% and 10% respectively. Despite Colombia's significant potential for RE, it only represents the 7% of CDM projects (Figure 3).

Figure 4 presents the number of projects in Latin America by type of source. It outlines an increasing participation of RE projects (56%) and Methane avoidance projects (21%).

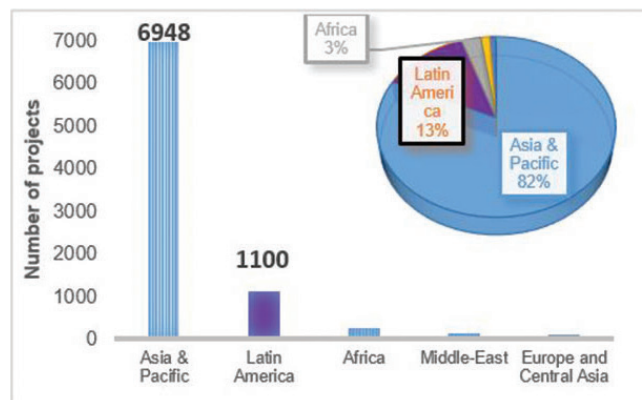


Figure 2. Number of CDM projects by region in the world¹⁸.

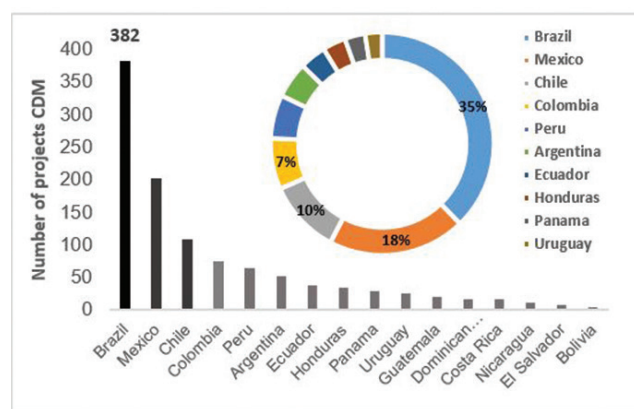


Figure 3. Number of projects CDM in Latin America¹⁸.

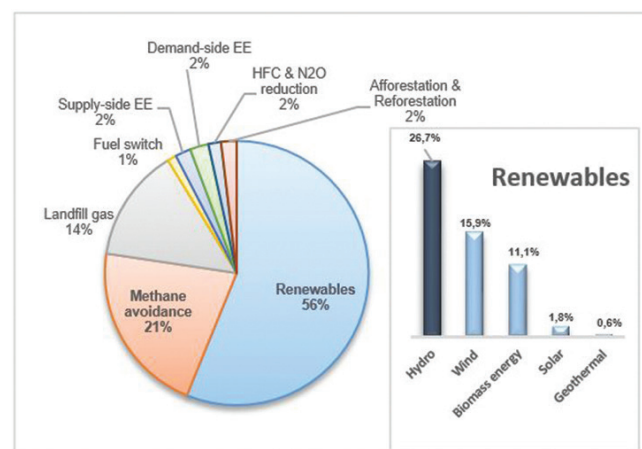


Figure 4. Number of projects in Latin America by type of source¹⁸.

The most noticeable participation of hydroelectric projects within the CDM in the region is characterised by their relevance in reducing important amounts of emissions. This fact represents significant income which helps financing CDM operations¹⁹. In addition, it is relatively easy to calculate the amount of emissions that will be reduced and to establish monitoring and verification plans. These projects and general power generation projects interconnected to national electricity grids, like most of the Aeolic ones, are regulated by the World Bank's international criteria in order to determine their aggregation potential²⁰.

Although hydropower is a renewable energy source, it is also a mature low-cost technology that has had long tradition in Latin America. Hydropower projects range from a few hundred kilowatts for micro turbines to a few gig watts for larger projects. Therefore, the physical, environmental and social impacts of hydropower projects are highly variable; they range from potentially huge effects caused by large dam projects to insignificant ones caused by small flowing hydroelectric projects. Large hydro projects usually require long-term planning and integration of other aspects besides energy (e.g. the population displacement, water use, and agriculture)²¹. Hydropower facilities bring power, roads, industries and commerce to communities and as a consequence, they develop their economies, improve their access to health services and education, and enrich their quality of life.

Additionally, hydroelectric exploitation can actually foster regional integration and development besides its contribution to environmental protection, particularly through the implementation of small hydro power projects (SHP).

Many kinds of benefits can actually be brought to these SHP projects surrounding communities: populated centres (small towns) do not only obtain power but also they directly benefit from the employment generated and the promotion of small-scale industries and the improvement in their infrastructures. SHP projects have also helped to reduce the displacement of local residents (who look for better opportunities), the creation of schools, parks and hospitals. On the other hand, social challenges like the unskilled labour force, corruption, some bureaucratic practices, ambiguous government policies, managerial problems and the resistance to change from locals are also relevant factors to be considered²².

Another important factor that has helped to lead the experts' interest 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 large 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^{5,10,23}.

SHP projects represent a cheap solution for power deficiency. The so-known *non-interconnected zones* (remote, rural and mountain areas) in Latin America can benefit from SHP projects (taking into account that expanding the grid system to those zones is comparatively more expensive). However, most RE technologies are still in the process of being developed; many important innovations in this field are likely to emerge. Considering the constant changes in the world's economy, it is unrealistic to assume that technologies would not change in the future along with science and country policies. These changes in technologies will make it possible to identify the most appropriate ones for a given context based on the status of local industries and conditions at a particular time.

Some nations find it more feasible to start focusing on mature technologies, however supporting all stages of technology, development and deployment instead of limiting funding to either the early or the late stages has been shown to be more effective. In other words, focusing only on mature technologies brings the drawback of ignoring new technologies with future potential. Therefore, improving power efficiency is the cheapest, fastest and most environmentally friendly way to meet a significant portion of the world's energy needs^{10,24}.

The region has a long record on hydropower development which has made it to become one of the leading suppliers of CDM projects in the world thanks to the institutional support from the governments of the region by signing and implementing the Kyoto Protocol. It includes the approval of CDM system projects and the increasing presence of local experts in institutions for promoting the CDM. Among these projects, there are hydroelectric projects which are eligible for carbon credit certificates.

Small hydropower projects remain one of the most appropriate options to meet the increase in energy demand, particularly in countries like Colombia, where a huge power potential is available. Its clean and renewable nature contrasts to fossil fuel based sources since these pollute the environment⁵.

4. Conclusions

The policy landscape on renewable energies, like the own renewable energy sector, is constantly and rapidly evolving. Latin America is no exception: the region has been a pioneer in designing and implementing specific mechanisms for the promotion of renewable energy, such as auctions and bio fuel mandates. Mobilisation of RE finance requires a holistic policy strategy, that is tailored to the local context and that combines a supportive regulatory framework with targeted interventions. Regulatory frameworks should include both energy policy and finance policy mechanisms. Public finance programmes should offer a flexible package of financing mechanisms, seek to maximise leverage of additional financing, and adopt a portfolio approach that avoids creating path dependency on any specific set of technologies. It is essential that governments overtake define the necessary studies and activities well in advance to identify conflicts and possible sites for the works so that it facilitates removal of uncertainties during project implementation. The interaction and mutual support between the authorities of the energy sector and water resources and affected communities are required both to meet the most urgent to the indicative long-term planning that allows successfully face future conflicts problems.

Given the current global context, particularly the economic context, it is undeniable that Latin America evidences relevant opportunities for being a major player thanks to its high hydroelectric potential and the possibility to participate in the international carbon market through the sale of Certified Emission Reductions; this is caused mainly by the domestic demand reduction commitments made in the European Union and Japan. This has helped the consolidation of this market.

Consequently, the CDM is established as an environmental and economical alternative for Latin America to ensure not only an income scheme but also to promote research and development activities related to the energy & environmental technology industry. Finally, CMD projects could be implemented in other sectors such as water, infrastructure systems and even the waste management sector. Additionally, future research should involve the combination of financial mechanisms, such as convertible bonds and securitization, leading to attracting more investors through an Integrated Latin American Market.

5. References

1. United Nations: Framework Convention on Climate Change. UNFCCC. Available from: <http://unfccc.int/2860.php>. Date accessed: 01/11/2014.
2. Vitousek PM. Global environmental change an introduction. *Annual Review of Ecology and Systematics*. 1992; 23:1–14. Crossref
3. Lokey E. Renewable Energy Project Development under the Clean Development Mechanism. *Sustainable Future*. Earthscan: London. 2009; 361pp.
4. Para comprender el Cambio Climático: Guía Elemental de la Convención Marco de las Naciones Unidas y el Protocolo de Kioto. PNUMA, UNFCCC. Available from: <http://www.cd4cdm.org>. Date accessed: 13/03/2015.
5. Duque EA, Gonzalez-Ruiz JD, Restrepo JC. Developing Sustainable Infrastructure for Small Hydro Power Plants through Clean Development Mechanisms in Colombia. *Procedia Engineering*. 2016; 145:224–33. Crossref
6. Abdmouleh Z, Alammari RAM, Gastli A. Recommendations on renewable energy policies for the GCC countries. *Renewable and Sustainable Energy Reviews*. 2015 Oct; 50:1181–91. Crossref
7. Ellis J, Winkler H, Corfee-Morlot J, Gagnon-Lebrun F. CDM: Taking stock and looking forward. *Energy Policy*. 2007; 35(1):15–28. Crossref
8. Zhang C, Yan J. CDM's influence on technology transfers: A study of the implemented clean development mechanism projects in China. *Applied Energy*. 2015; 158:355–65. Crossref
9. Zhang Z. China in the transition to a low-carbon economy. *Energy Policy*. 2010; 38(11):6638–53. Crossref
10. Kaygusuz K. Energy for sustainable development: A case of developing countries. *Renewable and Sustainable Energy Reviews*. 2012; 16(2):1116–26. Crossref
11. Pronostico del Deutsche Bank sobre el Mercado MDL - CERs al 2020. Available from: <http://lista.rds.org.hk/pipermail/cambioclimatico/attachments/20100805/fa259fce/attachment-0001.obj>. Date accessed: 13/03/2015.
12. Subbarao S, Lloyd B. Can the clean development mechanism (CDM) deliver? *Energy Policy*. 2011; 39(3):1600–11. Crossref
13. Watts D, Albornoz C, Watson A. Clean Development Mechanism (CDM) after the first commitment period: Assessment of the world's portfolio and the role of Latin America. *Renewable and Sustainable Energy Reviews*. 2015 Jan; 41:1176–89. Crossref
14. Economic sustainability: The business of staying in business. Available from: http://isites.harvard.edu/fs/docs/icb.topic140232.files/RD_economic_sustain.pdf Date accessed: 13/03/2015.

15. Kolshus HH, Vevatne J, Torvanger A, Aunan K. Can the Clean Development Mechanism attain both cost-effectiveness and sustainable development objectives? CICERO Working Paper. 2001; 8:1–25.
16. Financial Mechanisms and Investment Frameworks for Renewable in Developing Countries. Technical report, International Energy Agency - IRENA. Report No: December 2012. Available from: http://irena.org/Finance_RE_Developing_Countries.pdf. Date accessed: 13/03/2015.
17. Policymaker's guide to feed-in tariff policy design. National Renewable Energy Laboratory. Available from: <http://www.nrel.gov/docs/fy10osti/44849.pdf>. Date accessed: 13/03/2015.
18. CDM/JI Pipeline Analysis and Database. Available from: www.cdmpipeline.org. Date accessed: 10/12/2016.
19. Duque EA, Patino J, Velez L. Implementation of the ACM0002 methodology in small hydropower plants in Colombia under the Clean Development Mechanism. *International Journal of Renewable Energy Research IJRER*. 2016; 6(1):21–33.
20. State and Trends of the Carbon Market 2012. World Bank Institute. Available from: <http://documents.worldbank.org/curated/en/749521468179970954/State-and-trends-of-the-carbon-market-2012>. Date accessed: 10/12/2016.
21. Energías Renovables en América Latina 2015: Sumario de Políticas. Technical report, International Renewable Energy Agency - IRENA. Report No.: June 2015. Available from: http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Latin_America_Policies_2015_ES.pdf. Date accessed: 05/10/2015.
22. Khan R. Small Hydro Power in India: Is it a sustainable business? *Applied Energy*. 2015 Aug; 152(15):207–16. Crossref
23. Xingang Z, Lu L, Xiaomeng L, Jieyu W, Pingkuo L. A critical-analysis on the development of China hydropower. *Renewable Energy*. 2012 Aug; 44:1–6. Crossref
24. Olsen KH, Fenhann J. Sustainable development benefits of clean development mechanism projects: A new methodology for sustainability assessment based on text analysis of the project design documents submitted for validation. *Energy Policy*. 2008 Aug; 36(8):2819–30. Crossref