CHAPTER 7

USE OF THE CDM BY THE BRAZILIAN INDUSTRY: CONSIDERATIONS IN FAVOR OF ENERGY EFFICIENCY AND NEW TECHNOLOGIES[1]

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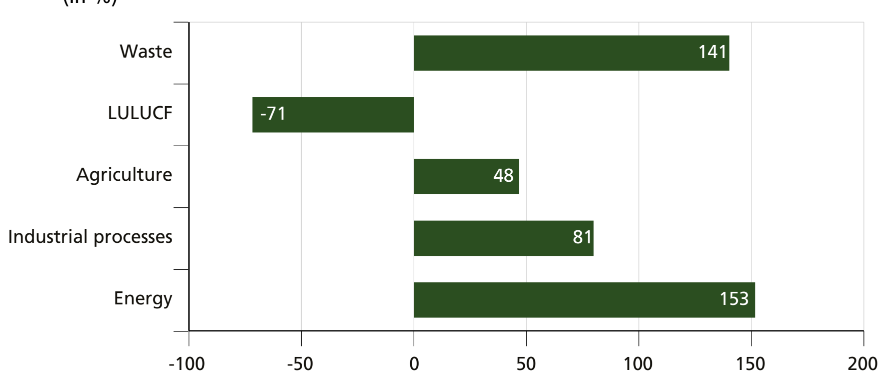
1 INTRODUCTION

The industrial processes sector, as adopted in the official reports for the monitoring of Brazilian GHG emissions (Brazil, 2016c), comprehend the emissions resulting from industrial activity which are not the result of fuel combustion and comprise the following subsectors: mineral products, metallurgy and chemistry, production and consumption of hydrofluorocarbons (HFCs) and sulfur hexafluoride – SF_6 (Brasil, 2016a).

In this context, recent estimates indicate that, in 2014, the industrial sector accounted for 7% of Brazil's total net GHG emissions[3] (Brazil, 2016a), but, despite its small contribution to the total Brazilian GHG emissions, it presented an expressive positive variation from 1990 to 2014, similarly to the other sectors with exception of the LULUCF sector (graph 1).

GRAPH 1
Variation in GHG emissions/removals in Brazil (1990-2014)
(In %)



Source: Brazil (2016a).
Elaboration of the author.

1. The author thanks Paula Bennati Shayani, who for many years has been at the forefront of discussions on climate change as a representative of the National Confederation of Industry (CNI, in Portuguese), for her contribution to initial stages of writing this chapter. The author also thanks Mauro Meirelles de Oliveira Santos for the authorship of the texts of annexes A and B.

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3. Considers GHG emissions and removals promoted by the land use sector, land use change and forestry (LULUCF) sector.

Several alternatives can be implemented by Brazilian industries to reverse the emissions scenario, for example, the substitution of fossil fuels by renewable fuels or less intensive in GHG emissions and the promotion of energy efficiency measures, such as heat recovery from processes to generate energy for own consumption.

From 2005 – when the Kyoto Protocol came into force – until 2012 – the year from which a sharp drop in in the registration of projects was perceived – the Clean Development Mechanism (CDM) contributed to the implementation of emission reduction projects of the industrial scope in Brazil.

This chapter will address some initiatives conducted by representative institutions of national industry focused on the climate agenda, what were and the impacts of Brazilian CDM projects in the industrial sector. It will also present some of the main perceived barriers for the execution of CDM projects; and the future prospects for the sector's emission reduction goal to be achieved, in line with the commitments established in recent international agreements.

2 CDM PROFILE AND PERFORMANCE IN THE INDUSTRIAL SECTOR

By May 2018, 342 CDM project activities[4] had been registered with the United Nations Framework Convention on Climate Change (UNFCCC), of which twenty had been developed by industries[5] that are distributed in sectoral scopes:[6] Scope 1 – Energy industries (renewable/non-renewable), nine CDM project activities; Scope 5 – chemical industry, nine CDM project activities; and scope 9 – metal production, two CDM project activities.

Despite corresponding to a small portion of the total number of registered CDM projects, the initiatives of the industrial sector correspond to a reduction of 62,464ktCO_2e or 47% of certified emission reductions (CERs) achieved by Brazilian projects.[7] The relevance of this contribution is mostly attributed to a single project developed by the chemical industry sub-sector (scope 5), while the other projects contribute approximately equally (graph 2 and table 1).

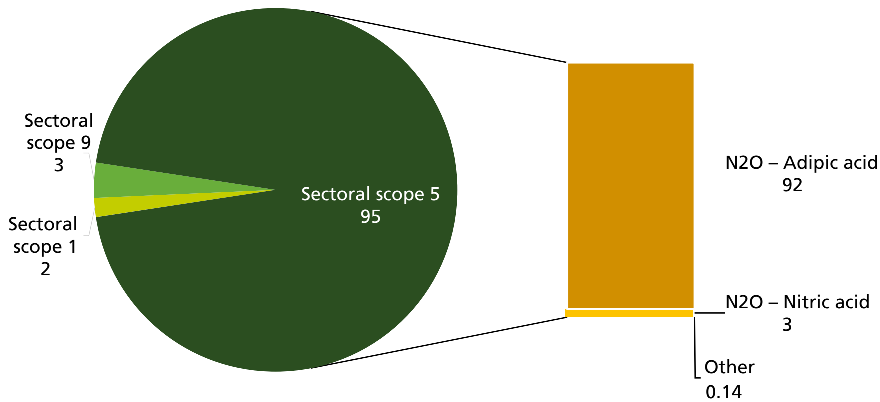
4. According to Annex A of the Kyoto Protocol, the sectors/source categories were subdivided into energy, industrial processes, use of solvents and other products/agriculture, waste and others. Industrial processes involve: mineral products, chemical industry; metal production; other production; production of halocarbon and sulfur hexafluoride; consumption of halocarbons and sulfur hexafluoride; others. Energy includes the transformation and construction industries among others.

5. The analysis presented in this chapter disregards the following types of CDM project activities: hydroelectric; landfill gas; energy generation from solar, biomass and wind sources; energy distribution; and methane avoidance.

6. Sectoral scopes correspond to the set of activities within the same sector and that share the same source of GHH emissions, as listed in Annex A of the Kyoto Protocol, available at: <https://bit.ly/2tilXzH>. Accessed on: May 15th, 2018.

7. The analysis presented includes the emission reduction corresponding to the CERs voluntarily canceled (0.7% of the total of the CERs issued for the projects of the industrial sector under analysis).

GRAPH 2
Representativeness of registered CDM projects in the Brazilian industrial sector, by sector scope
(In %)



Source: UNEP (2018a).
Elaboration of the author.

TABLE 1
Certified emission reductions of CDM projects in the industrial sector, by type and scope

Scope	Type of CDM project	Number of projects	Certified emissions reductions (kRCEs)[1]
1 – Energy industries (renewable/non-renewable)	Energy efficiency – own use	3	353
	Fossil fuel switch	6	712
	Subtotal	9	1,065
5 – Chemical industry	Adipic acid – N_2O	1	57,603
	Use of CO_2	1	10
	Nitric acid – N_2O	4	1,772
	Fugitive emissions	3	78
	Subtotal	9	59,463
9 – Metal production	Perfluorocarbons -PFC	1	0
	SF_6	1	1,936
	Subtotal	2	1,936
Total		**20**	**62,464**

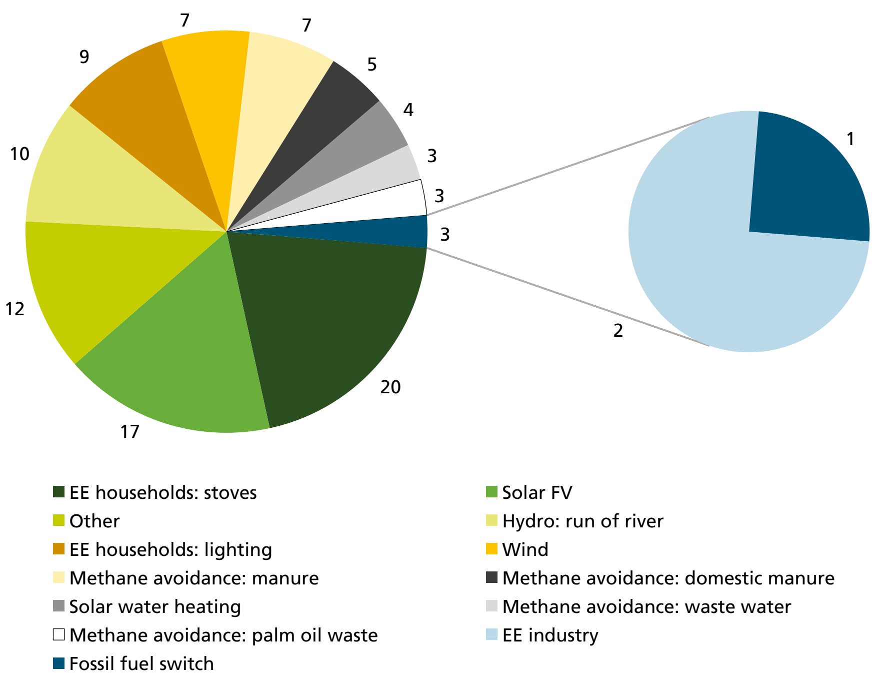
Source: UNEP (2018a).
Elaboration of the author.
Note: [1] One CER is equivalent to one tCO_2e.

Its worth mentioning that, between the two registered projects in scope 9, only one successfully issued CERs, illustrating a possible barrier to the quantitative contribution to GHG emission reductions of CDM projects in the industrial sector. From the total number of registered projects considered in the analysis, seven did not issue CERs until the beginning of May 2018, possibly indicating problems in the implementation of the projects or in the process of certifying emission reductions.

However, the qualitative observation of Scope 1 projects, which include fuel switch and energy efficiency activities for own use,[8] reveals the wide range of industries that could benefit from mechanisms such as the CDM to reduce GHG emissions from their production processes, as they were developed in different industrial units, such as: petrochemicals, cement plants, metal producing industrial units, pulp and paper mills, among others.

As for the registration of Program of Activities (PoA), by May 2018, only ten projects in which Brazil in the Host Party had been registered, none of which consists of initiatives undertaken by the industrial sector.[9] In global terms, only eight PoAs, or less than 3% of the registered PoAs, correspond to the implementation of activities aimed at reducing GHG emissions by the industrial sector – two PoAs of fuel switch; and six of energy efficiency in the industry (graph 3).

GRAPH 3
Distribution of PoAs registered in the world, by type of activities
(In %)



Source: UNEP (2018b).

8. Energy generation and biomass projects, which correspond to sectoral scope 1, are analyzed in Chapter 1 of this publication.
9. For further information on registered PoAs by Brazil, see Chapters 2 and 4 of this publication.

3 HIGHLIGHTS REGARDING THE IMPLEMENTATION OF THE CDM IN THE INDUSTRY

The implementation of CDM industrial sector projects presents some success stories, such as N_2O emission reduction projects, and episodes that illustrate the barriers faced by activities, not only related to industries, but also to other sectoral scopes. Issues related to methodologies and calculations of emission factors were, in many opportunities, determinants for the success, or not, of undertakings in the sector.

In addition, there has been, and still there is at the current moment of climate negotiations, a paradox between the criteria for the public availability of the CDM projects and patents registration in the industry. Many of the advances made by the industry are patented and, for reasons of competitiveness, remain confidential for as long as the right to register the patent lasts. This conduct is sometimes confronted with the CDM process requirement that all project documentation must be made publicly available, including project descriptions, containing information on how emission reductions are achieved and financial information if this is used to inform compliance with the requirement of project additionality.

It is possible to sustain, to a certain extent, the availability of information, since it favors the replicability of projects, increases global environmental gains. As in the other examples presented in this section, it is intended to leverage subsidies from the experience observed in the implementation of projects in the industry segment, with a view to future mechanisms being made feasible thanks to preexisting initiatives, or avoiding the misunderstandings of the past, consequently, benefiting the entire sector with opportunities from emission reductions.

3.1 Nitrous oxide projects (N2O): additionality, leakage and significant environmental gains

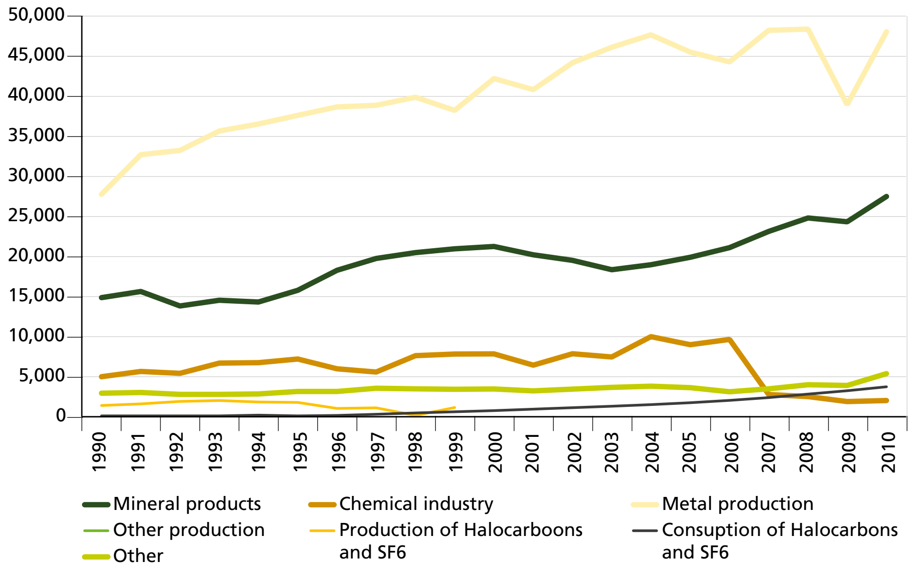
CDM projects aimed at reducing N_2O emissions make an important contribution to GHG emissions, due to the high Global Warming Potential (GWP) of this gas (310 for the first commitment period of the Kyoto Protocol, and 298 for the second commitment period).[10] In this regard, the Brazilian CDM Projects in Sectoral Scope 5 have contributed to a GHG emission reduction of 59,463ktCO_2e, and Rhodia's project alone represents 97% of the contribution to the reduction of GHG emissions from the projects in the sector. Registered on December 25th, 2005, this was the first CDM project in the industrial sector and consisted of preventing N_2O emission directly into the atmosphere after the generation of adipic acid.[11]

10. GWP information for the different GHGs is available in table 2.14 at https://bit.ly/2MbXxz2. Accessed on: May 15th, 2018. During the first commitment period, data from the IPCC Second Assessment Report was used. In the second commitment period, information for a hundred-year horizon is considered.

11. Project documents are available in English at https://bit.ly/2JUNZMd. Accessed on: May 5th, 2018.

In fact, the implementation of projects in the chemical industry sub-sector had an incredible reach, as they contributed to a drastic reduction in emissions of the industrial sector from 2006 – which coincides with the beginning of the crediting period of the adipic acid emissions reduction project in November of that same year (graph 4).

GRAPH 4
Evolution of emissions, by sub-sector of Brazilian industry (1990-2010)
(In GHG emissions/GgCO_2)



Source: UNFCCC.[12]
Elaboration of the author.

Despite the positive effects in terms of significant reductions in GHG emissions provided by this type of project, after its implementation and subsequent issuance of CERs, there was an intense debate about its real contribution, specifically related to issues of additionality and fugitive emissions.[13] Notwithstanding criticism, the initiative is notable as a potential CDM contribution to the sector.

3.2 Energy efficiency – was a clean baseline ever an issue?

Brazil has an electricity matrix strongly influenced by renewable energy sources, such as hydroelectricity, which leads to a low result for the CO_2 emission factor of the National Interconnected System (SIN), or at least not as high as other

12. For further information, see https://bit.ly/2Nl5u5X.
13. For further information on fugitive emissions issues, refer to Schneider (2011) and Schneider, Lazarus and Kollmuss (2010).

countries' matrices that use non-renewable sources, such as petroleum or coal byproducts, for this purpose.

This fact ends up creating a barrier to the implementation of energy efficiency projects in the industry that aim at the efficiency of electricity consumption from the grid or its replacement by other renewable sources, since the revenues obtained from the commercialization of CERs – determined by the amount of emission reductions – calculated, in a simplified manner, by multiplying the amount of energy that is no longer consumed by the CO_2 emission factor of the grid, are lower than the investment required to implement the projects.

During the first commitment period of the Kyoto Protocol, there was intense debate on the calculation of the grid emission factor. Annex A provides additional information on some of the issues discussed during the publication process, by the Ministry of Science and Technology, Innovations and Communications (MCTIC), of the national CO_2 emission factor.

However, the three Brazilian energy efficiency CDM projects include measures aimed at increasing efficiency in thermal energy generation by heat recovery from processes, with only one of them having been successful in obtaining CERs so far. In this context, it can be inferred that an explanation for the low number of projects in this category is the fact that they are complex activities, of little return; or then, are not directly related to the productive process of the manufacturing unit, which in theory would lead to a decrease in interest in it execution.

It is assumed that some of the main barriers to the implementation of energy efficiency measures in industry are: aversion to risks arising from the adoption of new, more efficient technologies; lack of public resources specifically designed to implement energy efficiency measures (which are usually for the residential, commercial and public sectors); a supposed short-term view of industry, which favors investments in production; low technical capacity for the identification and execution of energy efficiency measures; little attention to thermal insulation procedures, which would reduce consumption (GVces, 2015; Brazil, 2011; Rathmann et al., 2017)

Finally, it can be observed from the data in Table 1 that, for projects with an energy component in the industrial sector, there was a higher prevalence of fuel switch projects. Five of the six registered projects had issued CERs by May 2018. It should be noted that these projects contribute little to GHG emissions reductions in the industrial sector, compared to the avoided N_2O project, previously mentioned in item 3.1.

3.3 The need to overcome methodological and procedural barriers

3.3.1 Cement projects: methodology and additionality issues

Cement production is the second most GHG-emitting industrial activity in the Brazilian industrial sector, preceded only by pig iron and steel production. In 2014, the cement industry accounted for 28.5% of the industrial sector's GHG emissions (Brazil, 2016a). Worldwide, the largest sources of GHG emissions in cement production are related to the production of clinker (50.0%), the fuel burning for furnace heating (40.0%) and the use of electricity and transportation (10.0%).[14]

In Brazil, two projects[15] were submitted by the cement industry aiming at increasing the use of materials other than clinker, but were not approved by the UNFCCC registration process. These projects together sought to reduce emissions during their respective first crediting periods amounting to 2,945ktCO_2e, and the main reasons for their rejection by the CDM Executive Board at that time were an alleged fail to comply with aspects related to the requirement of additionality of projects and prior consideration of the mechanism for carrying out the activity.[16]

It is worth noting that the Brazilian cement industry has historically used alternative materials to replace clinker, which contributes to its CO_2 emissions per ton of cement being lower than the world average (Brazil, 2013). However, attention should not be diverted to other specific indicators of clinker production. The data in graph 5 clearly demonstrate that Brazil does not follow the global trend of reducing the carbon intensity in clinker production, the largest source of emissions from cement production.

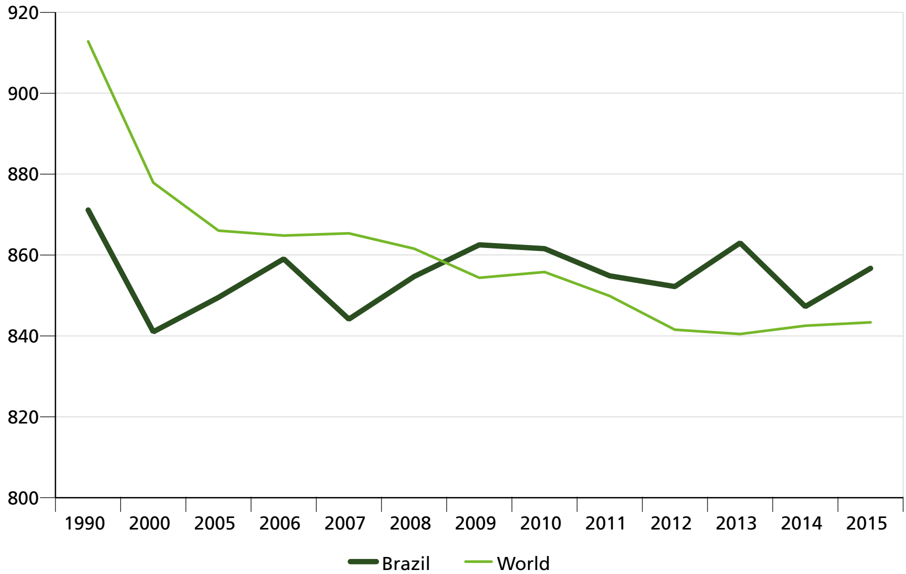
14. For further information, access https://bit.ly/2JWBgbl.

15. Votorantim Cimentos Project, available at: https://bit.ly/2tg3hk7; and Mizu Project, available at: https://bit.ly/2tdh0ld. Accessed on: May 9th, 2018.

16. CDM Executive Board reports containing reasons for projects rejection are available at: https://bit.ly/2JZ4Hdl. Accessed on: May 9th, 2018.

GRAPH 5

Comparison of Brazilian and global CO_2 emissions, weighted by clinker production
(In kg of CO_2/t clinker)



Source: Cement Sustainability Initiative. Available at: https://bit.ly/2tkiFMo.
Elaboration of the author.

It should be recalled that the Executive Board, after rejecting the Brazilian projects in June 2007, decided to put on hold[17] the ACM0005 methodology[18] and to recommend its revision due to the difficulty in determining the barriers to project implementation, which were an integral part of the claims for the analysis of additionality.

There is undeniable growing knowledge in GHG quantification and formulation of methodologies and procedures for the execution of CDM projects, but examples such as these, discussed in 3.3.1, illustrate the barriers faced by many projects regarding the methodological issue and the efforts to prove additionality. The two Brazilian projects have not resumed the registration process so far.

17. Minutes of the 46th CDM Executive Board Meeting. Available at: https://bit.ly/2KcO0uf. Accessed on: May 9th, 2018.

18. The ACM0005 methodology and all its revisions are available at the link: https://bit.ly/2tdh0ld. Accessed on: May 9th, 2018.

3.3.2 Expectations regarding the use of PoA by the industry

In 2007, the CDM Executive Board approved the first version of a document called *Guidance on the registration of project activities under a program of activities as a single CDM project activity*.[19] At subsequent meetings, the Executive Board improved the decisions on the implementation of this new concept and in July 2007 approved the first versions of the CDM-PoA-DD-Form project design document,[20] which marks the effective possibility of implementing CDM Program of Activities (CDM-PoA) under the Kyoto Protocol.

PoAs consist of a set of CDM activities, called CDM Component Project Activities (CPA), registered under the same project, which share the same technology, and therefore use the same CDM methodology, or set of methodologies, for the calculation of GHG emission reductions. The main difference between this new scheme and the grouping of activities into a CDM project activity is that CPAs can be included after the PoA registration for a longer crediting period lasting up to 28 years – or 60 years for forest scope projects (Climate Focus, 2013).

The main advantages of developing a PoA rather than a CDM project activity are: a faster validation process once that at the time of registration only one CPA needs to be submitted as a practical case of PoA implementation and the inclusion of the subsequent CPAs is made directly by the Designated Operational Entity; each CPA has an individual crediting period, which increases the period for obtaining PoA credits; greater flexibility to include new projects since CPAs can be included or excluded throughout the PoA crediting period; and, the possibility of conducting the verification of CERs (CNI, 2010; Climate Focus, 2013).

The benefits of developing PoAs over traditional CDM projects would be able to reduce the time required to register projects and the transaction costs in executing all phases, from validation to verification and subsequent issuance of CERs. Given this favorable scenario, there was an expectation that the number of registered projects would increase, but, in practice, this was not observed.

In terms of contribution to emissions reduction, no PoA of the industry sector had issued CERs by May 2018 (table 2). This chapter is not intended, however, to address what issues contributed to the small number of projects in the industrial sector or the non-issuance of CERs, which may be related either to difficulties in monitoring and verifying the CERs, or to the non-physical implementation of the project for reasons not related to the CDM project itself.

19. Annex 15, 28th EB Meeting on December, 2006. Available at: https://bit.ly/2KazfrD. Accessed on: May 16th, 2018.
20. 33th EB Meeting on July, 2007. Available at: https://bit.ly/2M8S4ca. Accessed on: May 16th, 2018.

TABLE 2
Outcomes of activities under a CDM Program of Activities

	Estimated emissions reductions (ktCO2 by 2020)	Verified emissions (tCERs by May 2018)
PoA Brazil	26,573	1,244
PoA world	331,331	13,852
PoA world – industry	568	0
CDM Brazil	493,119	133,588
CDM industry	103,090	62,464
CDM world	9,568,198	1,904,100

Sources: UNEP (2018a) and UNEP (2018b).
Elaboration of the author.
Obs.: Results in terms of estimated GHG emission reductions by 2020, and emissions of CERs completed by May 2018.

It is known, however, that for energy efficiency projects in the industry, a major barrier to the development of the PoA is at its initial design phase, when details of the proposed activities (including equipment) are required, and the establishment of the eligibility criteria that a CPA must meet to be included in its scope.

These criteria often require a thorough detailing, depending on methodology and activity, which can be considered a difficult factor for framing future CPAs. Of the industrial sector PoAs registered in other countries, none led to the inclusion of additional CPAs to the one included at the moment of the PoA registration (UNEP, 2018b).

3.4 RELEVANT ISSUES ON PRICING FROM AN INDUSTRY PERSPECTIVE

A Technical Chamber on Carbon Pricing is being created by the Brazilian Industry Climate Network (*Rede Clima da Indústria Brasileira*, in Portuguese),[21] aiming at articulating, capacitating and consolidating contributions from the industrial sector, comprising the seven sectors regulated by the Industry Plan, to the Partnership for Market Readiness (PMR) Project[22] of the Finance Ministry. This Chamber must be composed of representatives in the areas of Economy, Environment and Sustainability of the CNI – Brazilian Industry Confederation, industry federations, sectoral associations and companies.

It is worth mentioning some specific concerns of the sector regarding carbon pricing, which are currently a great challenge for the private sector, as described below.

1) Need to reconcile national pricing schedules with those being established in other countries.

21. To know more about this network, see, in this sense, section 4 of this text.

22. The Ministry of Finance's PMR project will study carbon pricing instruments and their impacts on the Brazilian economy over the 2016-2019 horizon. For further information, see Chapter 15 of this publication.

2) Non-acceptance of the carbon-based accounting proposal, compared with other modalities based on absolute targets and the necessity to meet existing market policies, such as that of China, which is on the way to absolute emissions.

3) Concern about the need to consider early actions, which is the case of many companies that have anticipated legal requirements.

4 THE ROLE OF CNI TO SPREAD KNOWLEDGE ABOUT CDM IN BRAZIL

The CNI represents the Brazilian industry. It is the highest body of the trade union system of industry and, since its foundation in 1938, defends the interests of the national industry together with the Executive, Legislative and Judiciary powers, in addition to various entities and bodies in Brazil and abroad. It represents 27 industry federations and 1,250 employer's unions, to which almost 700 thousand industries are affiliated.[23]

In partnership with the Center for Strategic Studies and Management (CGEE, in Portuguese) and the Government, under the supervision of MCTIC,[24] CNI organized and sponsored CDM training courses in different states of the country, through industry federations distributed among the various regions.[25] The objective of the training activities was to disseminate the possibilities that the CDM presented to the industrial sector for the achievement of GHG emission reductions, through the awareness of the business class, striving to disseminate knowledge and create a critical mass capable of carrying out the identified opportunities (CGEE, 2008).[26]

Also trough CNI, as presented by Cantarino (2017), the Brazilian industrial sector created the Brazilian Industry Climate Network, which has the following objectives:

- carry out articulation, interlocution, institutional relations, negotiation and defense of the Brazilian industry interests before government agencies, technical groups and business entities at the national and international levels;

23. Institutional profile available at: https://bit.ly/2tp6zAY. Accessed on: May 10th, 2018.

24. At the time of the launch of the initiative, the Ministry's formal name was Ministry of Science and Technology (MCT).

25. The courses started in 2006 as a pilot project in the industry federations of the states of São Paulo (FIESP), Rio de Janeiro (FIRJAN), Pernambuco and Rio Grande do Sul. In 2017, as an effective course, it was offered in the industry federations of the states of Goiás, Ceará, Minas Gerais, Bahia, Maranhão, Santa Catarina, again in Sao Paulo and Rio de Janeiro; as well as at the Federal District.

26. For further information on the courses offered in this initiative, which began in 2008 and lasted until 2011, can be accessed at: https://bit.ly/2MOFn7o. Accessed on: May 10th, 2018. To consult the work, in Portuguese, Manual de capacitação: mudança climática e projetos de Mecanismo de Desenvolvimento Limpo, produced within the scope of this initiative, the link is available at: https://bit.ly/2lqPt1O. Accessed on: June 5th, 2018.

- promote analysis of competitiveness and strategic positioning of the Brazilian industry in relation to national regulations and international agreements on climate change;
- spread the information, qualify the debate and align the position of the industrial base;
- identify priority themes, trends, risks and opportunities for the industry sector's value chain in the climate change agenda; and
- prepare the industrial sector for the future, through the promotion of business development, partnerships for innovation, technology development, market and incentives, aiming at consolidating a low carbon economy.

The following are the lines of work of the Brazilian Industry Climate Network in its different approaches:

- technical and regulatory – elaboration of technical opinions; competitive analysis, training and strategic positioning of the Brazilian industry before national regulations (policies, bills and executive projects, decrees and provisional measures); and international agreements on climate change;
- policy and institutional – articulation of the industrial sector through the Brazilian Industry Climate Network, negotiation and defense of interest in forums, meetings, work groups, technical chambers and events on climate change, promoted by governmental, nongovernmental entities and national and international business entities;
- economic and market – analysis and positioning on the economic and market impacts on the Brazilian industry value chain, regarding carbon pricing; adaptation measures, prevention and risk management of climate change; and financing lines for the consolidation of a low carbon emission economy; and
- technological and innovation – foster the development of technology and innovation in the industrial sector towards the consolidation of a low-carbon economy through the establishment of partnerships; seek to reduce bureaucracy in access to technologies and financing; map trends and good practices; and creation of environments for exchange of experiences (connection between the industrial sector and startups).

5 CURRENT POSITION OF THE INDUSTRIAL SECTOR WITH REGARDS TO EMISSIONS MANAGEMENT AND PLANNING FUTURE ACTIVITIES

The Kyoto Protocol remains valid, even though the Doha Amendment[27] not being in effect. Despite the difficulties faced in recent years by the emission reduction market due to the significant fall in the value of CERs,[28] some Brazilian CDM projects issued CERs during the second commitment period of the Kyoto Protocol, including three of the twenty projects in the industrial sector analyzed in this chapter (two of N_2O and one of SF_6). The continuity of the actions foreseen in these projects is, directly or indirectly, related to the effects of the decisions made at the international level and, in some way to the internal policies on climate change.

The enactment of the National Climate Change Policy (PNMC, as in Portuguese), Law No. 12,187, of December 29th, 2009, made official the voluntary commitment assumed by Brazil during the Copenhagen Conference of the Parties and established internal targets for the reduction of GHG emissions, which, later, with the adoption of the Paris Agreement, were consigned in the Brazilian intended Nationally Determined Contribution (iNDC) submitted to the UNFCCC in September 2016 (Brazil, 2009).[29] Specifically for the industrial sector, the Brazilian iNDC highlights that the country is committed to "promoting new standards of clean technologies and expanding measures of energy efficiency and low-carbon infrastructure" (Brazil, 2016b).

In 2017, the MCTIC published the *Mitigation Options of Greenhouse Gas (GHG) Emissions in Key Sectors in Brazil,* which identified the main actions to be taken, as well as the barriers to be overcome by the country in order to comply with its iNDC targets in all economic sectors. Among the initiatives highlighted by the document for the industrial sector, listed according to the most cost-effective criterion, are the energy efficiency initiatives (table 3), in particular the efficiency in heat and steam recovery (Rathmann et al., 2017).

27. The Doha Amendment establishes the second commitment period of the Kyoto Protocol (2013-2020). For it to enter into force, 144 parts of the UNFCCC need to ratify it. By May 2018, 122 parts of the Convention had ratified the Doha Amendment, including Brazil, on February 13th, 2018. For further information on this agreement and its implications, see Chapter 12 of this publication. Ratification status can be found at: https://bit.ly/2mBJXNq. Accessed on: June 7th, 2018.

28. For further details on the emissions trading market, refer to chapters 14 and 15 of this publication.

29. The full document submitted by Brazil to the Convention, as well as the documents submitted by the other parties, is available in English at the link: https://bit.ly/2dZryCB. Accessed on: May 18th, 2018.

TABLE 3
Cost-effectiveness of mitigation options for iNDC compliance in 2025, for the industrial sector

Sector (segment)	Mitigation options	Mitigation potential ($MtCO_2e$)	Total cost (US$ millions)	Index
Industry (cement)	Fuel switch	0.7	0.9	1.3
Industry (chemicals)	Heat Recovery for Process Efficiency	1.2	9.7	8.1
Industry (cement)	Heat Recovery for Process Efficiency	3.2	33.3	10.4
Industry (steel)	Heat Recovery for Process Efficiency	0.2	2.4	12.2
Industry (other sectors)	Steam Recovery for Process Efficiency	7.0	119.2	17.0
Industry (chemicals)	Steam Recovery for Process Efficiency	0.9	22.8	25.3
Industry (other sectors)	Furnace efficiency and process optimization	2.4	84.6	35.2

Source: Rathmann et al. (2017).
Elaboration of the author.

Some of the instruments for the implementation of the PNMC, as determined by the decree that regulated it (Decree No. 7,390, of December 9th, 2009), are the sectorial plans. Of interest to the industrial sector, the Sector Plan for Mitigation and Adaptation to Climate Change for the Consolidation of a Low-Carbon Economy in Transformation Industry (Industry Plan), published in 2013, and the Sector Plan for Emission Reduction in the Steel Industry, still under development (Brazil, 2010), stand out.[30]

The Industry Plan initially comprised the aluminum, lime, cement, pig iron and steel, pulp and paper, chemical and glass industries, which accounted for 90% of the direct GHG emissions from the manufacturing industry in 2005. The plan is structures considering five action lines: carbon management; recycling and co-processing; energy efficiency and cogeneration; voluntary mitigation actions; and sustainable technologies (Brazil, 2013).

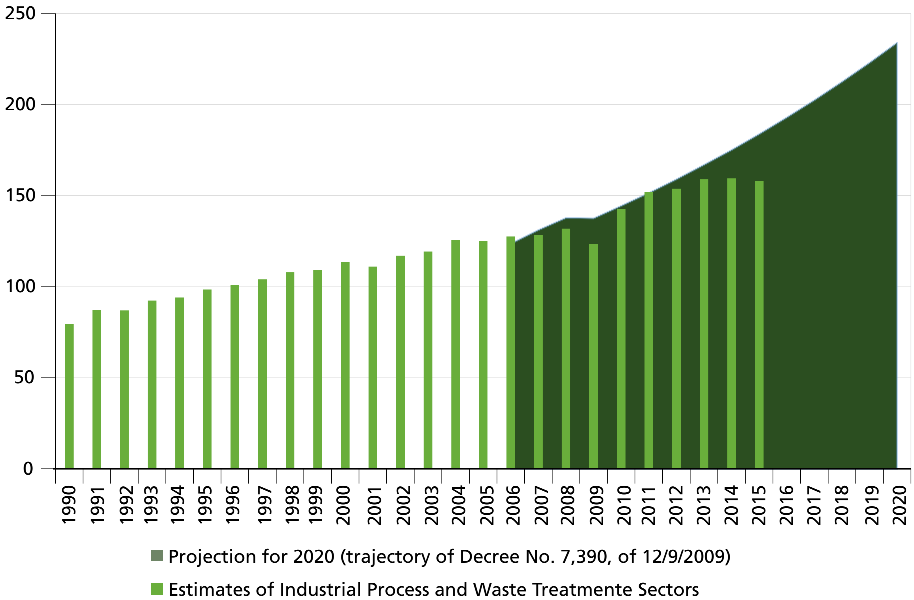
As indicated in the Industry Plan, GHG emissions reductions from the industrial sector would not be necessary to meet the reduction targets agreed by the country at the international level. It also highlights that the industries considered have a better environmental performance when compared to the industry performance of similar sectors worldwide.

In fact, although total emissions from the sector increased between 1990 and 2014 (graph 1), if we take the government monitoring data, which considers statistics from 2005 onwards, we can infer that emissions from the industrial sector and the waste treatment sector were 14% lower than the projections established by the PNMC's regulatory decree for the year 2015 – graph 6 (Brazil, 2017).

30. According to information available on the website of the Ministry of the Environment. Available at: https://bit.ly/2K7SIPb. Accessed on: May 28th, 2018.

However, it is worth noting that the projections, considered in the decree, for GHG emissions up to 2020 – and their respective targets – were calculated assuming a scenario of economic activity growth (gross domestic product – GDP) of 5% during the period, which was not achieved.

GRAPH 6
Emission estimates by 2015 and emission limit for 2020 for the industrial process and waste treatment sectors (1990-2020)
(In $TgCO_2e$)



Source: Brazil (2017).

As provided for in the decree, sectorial plans would have to be reviewed every two years after their publication, so that adjustments and possible actions could guarantee compliance with the agreed targets. However, since its publication, in 2013, the Industry Plan has not yet been revised.

It should be noted that several goals established in the plan have not yet been implemented. One example is the targets related to the National Energy Efficiency Plan (PNEf), which clearly points to the non-adoption of energy efficiency practices by the industrial sector (despite being the country's largest energy consumer) because investments in energy efficiency compete with investments in production (Brazil, 2011).

6 CLOSING REMARKS

It is a frequent argument of the various segments of the industrial sector that emission reductions should occur without compromising their growth. Technologies and solutions to accomplish this result while ensuring competitiveness already exist. Nevertheless, there are still barriers to their use from both a commercial and cultural point of view.

Given the fact that the contribution of the GHG emission reductions from industries, in terms of the number of CDM project activity registered, is smaller when compared to the other sectors, it is important to increase the pace and scale of its implementation.

Climate change policies must be based on economic competitiveness. This means prioritizing measures aiming at increasing energy consumption efficiency, capable of providing a significant share of the necessary reductions in GHG emissions. Likewise, it is also convenient to reinforce the special attention to sectors such as the steel and chemical industries, which face intense competition from countries that do not yet seek to cut their emissions.

The N_2O CDM projects are an emblematic example of how financial incentive policies, such as the CDM, allow for not-so-complex changes to be made rapidly by industry in proportion to the evidence of perceived gain. As discussed in this text, although the sector's emissions correspond to 7% of total emissions in Brazil, and therefore are not that representative, it can be said that there is an upward trend.

In addition, it is worth signing that, despite the national circumstances of each country, it is essential to implement several minimally coordinated policies so that there is no overlap between the federal, state and municipal levels. Also, policies that permeate different sectors must be aligned so as not to generate the need to produce the same information in different formats to meet the need of different agents.

Emission reduction opportunities in the industry are concentrated in activities of low perceived economic gain. Thus, there is no alternative but to implement other incentive policies that contribute to GHG emission reduction measures to be carried out by the sector and contribute, albeit on a small scale, to the fulfillment of the commitments established by the country in the international context of climate change negotiations.

In this regard, the government must consider mechanisms to protect sectors that are more sensitive to international competition and evaluate possible benefits to encourage the industrial sector to engage in the issue of climate change, reducing its emissions; without jeopardizing the insertion of the sector in the international market and the country's economic growth. Several examples have been presented by the industry in relevant fields, such as low-carbon development support policies, tariff incentives and the production and consumption of energy-efficient products and financing for energy efficiency.

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ANNEX A

USE OF THE NATIONAL INTERCONNECTED SYSTEM EMISSIONS FACTOR WITH THE ADJUSTED SIMPLE OPERATION MARGIN OPTION[1]

Resolution No. 8 of May 26th, 2008, of the Interministerial Commission on Global Climate Change (CIMGC) provided that the National Interconnected System (SIN) would be treated as a single system, with no subdivisions, for the purposes of any project activity in the Clean Development Mechanism (CDM) supplying or using the grid power. The Resolution also provided that emission factors would be published on a regular basis, in tCO_2/MWh, calculated for the single system and made available per month, day and hour on the CIMGC website.

The "Tool to calculate Emission Factor for an electricity system", mentioned in Resolution No. 8, allows, in its detailing, four options for the calculation of the operating margin. The alternative *i)* simple operating margin (OM), which cannot be applied to the Brazilian case, for having more than 50% of generation in water basis, which lead to alternatives *ii)* simple adjusted operating margin (OM); *iii)* Dispatch Data Analysis Operating Margin (OM); and *iv)* average operating margin (OM).

As per the decision in Resolution No. 8, emission factors published on an hourly basis are to be considered as option *iii*) Dispatch Data Analysis OM. While it can be understood that the publication of emission factors, as indicated in Resolution 8, addresses all projects, this is not the case. Projects that cannot be controlled hourly, such as energy efficiency, which estimates the energy savings by comparing the energy actually consumed (measured by the monthly bill) with the energy used at the baseline, or those projects that increase the capacity of an existing plant, where the comparison is made by the annual amount of energy generated, are not contemplated with the publication of the emission factor using the dispatch data analysis.

Option *iv*) average OM, is also published by the CIMGC, but because it represents an option that offers a very low value for the emission factor in the Brazilian case – more than 80% of clean generation, in practice it is only used for corporate inventories, for which it is explicitly indicated on the CIMGC website.

Option *ii*) simple adjusted OM would be the only one possible for the Brazilian case, allowing for a choice of an emission factor for a CDM project activity

1. Annex A text prepared by Mauro Meirelles de Oliveira Santos.

valid for an entire period, whether in advance and fixed for the entire crediting period (ex-ante), or afterwards, calculated for each year of monitoring (ex-post).

Apparently to meet projects that would like to use option *ii)* simple adjusted OM, the CIMGC requested the CDM Executive Board at its 50th meeting, from October 13 to 16, 2009, to include the following sentence in methodology ACM0002 (renewable electricity generation for the grid) and to review the "Tool to calculate Emission Factor for an electricity system": "Dispatch data analysis should be the first methodological choice. Where this option is not selected, project participants shall justify the reasons and may use the simple OM, the simple adjusted OM or the average emission rate method taking into account the provisions outlined hereafter".

After the Executive Board launched the CDM Methodology Panel (Meth Panel), it presented at its 43rd meeting a proposal that classified dispatch analysis as mandatory,[2] which was rejected during the 54th meeting of the Executive Board, when there was a new suggestion for the Meth Panel to study the ex-ante calculation for the simple operating margin and the adjusted simple operating margin, taking into account the data of the dispatch analysis. The Meth Panel presented, at its 45th meeting, an information note stating that calculation was not possible, but that another ex-ante calculation based on the dispatch analysis could be studied. The 56th session of the Executive Board considered this note and requested that the possibility be considered later. However, the subject was no longer raised. It is concluded that there is no ex-ante option for both the simple operating margin and the adjusted simple operating margin based on the dispatch analysis.

Thus, it is necessary for the CIMGC to disclose the emission factor based on the simple adjusted OM option, which can be used both ex-ante and ex-post, so as not to hinder the development of the aforementioned CDM project activities. Such emission factors can only be calculated with data from the National System Operator (ONS) that cannot be published.

Taking into account that the operating margin method for the analysis of dispatch data is the most accurate, the CIMGC may restrict the use of the simple adjusted OM option in Brazil, although it is an option authorized by the Executive Board and its use does not indicate, at first, higher or lower CO_2 reduction values, i.e. certified emission reductions – CERs (carbon credits). A simulation between the different options for OM is in the annex to this document.

It is also worth remembering that in 2012, a Brazilian project used the option of simple adjusted OM: Project No. 365, a Project Activity of the Wind Power Complex of Rio Grande do Norte and Ceará, received its letter of approval on

2. For the use of the verb shall in the English version. See the original text in the Bibliography used section of this appendix.

September 24th, 2012. The OM emission factors were calculated using information "provided by the ONS", according to the Project Design Document (PDD), including thermal generation and type of fuel used, although project proponents have not made them explicit in the project's public documentation.

The project was rejected for submitting data for financial analysis after the start of the project. Nothing was said about the calculation for the emission factor using the simple adjusted OM, and DNV Climate Change Services[3] validated such a calculation. The spreadsheet with all the data has not been published, but in the calculation of the CERs, according to the public spreadsheet on the UNFCCC website,[4] it is possible to see that the results for the emission factors do not match mine, related to the simple adjusted OM, and (construction margin, EF_{BM2010}: 0,1166 t CO_2/MWh in the PDD, against 0.1404 t CO_2/MWh, published by the CIMGC). In addition, the annual generation of energy dispatched does not match that provided to the Ministry of Science and Technology, Innovations and Communications (MCTI) by the ONS. As a result of this particular calculation of the project proponent, values lower than those calculated with the correct ONS data were used to calculate the project reductions, using a more conservative methodology, since they lacked accurate energy efficiency data, reducing the generation of CERs and hampering project performance.

Starting in 2014, after a few more considerations of its members, the CIMGC finally began to officially publish these emission factors as an official calculation.

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EB50:[5] 16 October 2009

28. In the context of a letter from one of the DNAs, the Board requested the Meth Panel to consider the following language from version 6.0 of ACM0002 and use it appropriately to revise the *Tool to calculate the emission factor for an electricity system*: "*Dispatch data analysis should be the first methodological choice*. Where this option is not selected project participants shall justify why and may use the simple OM, the simple adjusted OM or the average emission rate method taking into account the provisions outlined hereafter." This option of calculating the operating margin emission factor using the dispatch data analysis method should be considered particularly if the necessary data is available.

3. Designated Operational Entity by the United Nations Framework Convention on Climate Change (UNFCCC).
4. Spreadsheet 7682-20121011-CER SHEET.xls. Available at: https://bit.ly/2u62KRo.
5. For further information, see: https://bit.ly/2KEhyRR.

> Meth Panel Meeting 43 – 22-26 February 2010
>
> Annex 7 – Draft revision to *Tool to calculate the emission factor for an electricity system*:
>
> …
>
> Dispatch data analysis OM (option c) *shall* be used if (1) the data required to apply this option is publicly available and (2) off-grid power plants are not included in the project electricity system as per Step 2 above. For the dispatch data analysis OM, the emission factor shall be determined for the year in which the project activity displaces grid electricity and updated annually during monitoring.
>
> In case the grid emission factor is used to calculate project emissions or leakage, any of the four options could be used, provided that the conditions specified below are fulfilled for the selected option.
>
> …

EB53:[6] March 26th, 2010

27. The Board agreed to continue the consideration of the proposed revision to the *Tool to calculate the emission factor for an electricity system* at its next meeting.

EB54:[7] May 28th, 2010

25. The Board considered the draft revised *Tool to calculate the emission factor for an electricity system* and requested the Meth Panel to revert to the original tool *and revise it to allow the use of dispatch analysis data for the ex-ante calculation* of the operating margin emission factor in the simple operating margin and the simple adjusted operating margin. The Board requested the Meth Panel to recommend the final draft tool for consideration by the Board at its fifty-sixth meeting.

6. Access the site: https://bit.ly/2Kvoi54.
7. Available at: https://bit.ly/2lQX4Hc.

Meth Panel Meeting 45 – 9-13 August 2010

Annex 10 – Information note on the *Tool to calculate the emission factor for an electricity system*

Response from the Meth Panel to the request contained in paragraph 25 of the fifty-fourth meeting report of the Executive Board

1. The Meth Panel (the panel) is of the opinion that *it is not possible to use ex-ante dispatch data for the calculation of the simple operation margin or the simple adjusted operating margin emission factor* as requested by the CDM Executive Board, but that *it may be possible* to calculate *an* ex-ante operating margin emissions factor based on dispatch analysis data.

2. The panel believes that the use of ex post dispatch analysis data when available is the most accurate approach to determine the operating margin emission factors and should be used whenever possible. It should be noted however, that the use of the ex post dispatch analysis data operating margin requires the project proponents to obtain data on the displacement of the grid on an hourly basis.

3. This is the case for the majority of the project activities based on a low emitting power plant but not all. In some methodologies the displacement of grid electricity is obtained as the difference between power generation of the project activity plant minus the electricity which would have been generated in the baseline situation, which is determined only at the annually level (case of project activities increasing the capacity of an existing plant). The same applies to the majority of the demand side management project activities (use of energy efficient appliances) for which only annual electricity savings are available. This is the main reason why *the panel is inclined not to mandate dispatch analysis as priority*.

4. The panel is of the opinion that *further analysis* would be needed to determine if the use of *ex-ante dispatch analysis* is suitable compared with other methods of estimating operating margin. On one side, it can be argued that the dispatch of power plants at the margin of the merit order of generation is more susceptible to temporal variation than the average dispatch of power plants. Change in the relative price of fuel will affect the amount of generation of each power plant as well as the lambda factor, but its impact on the power plants at the margin of the merit order may be larger. On the other hand, in a host country with relatively stable relative prices of fuel and/or high variability regarding hydropower generation, the dispatch data would give a better representation of the power displaced by a project activity than an average based on all thermal power plants of the grid.

EB56:[8] September 17^{th}, 2010

32. The Board considered a note by the Meth Panel regarding the "Tool to calculate the emission factor for an electricity system" and requested the panel to perform further analysis to determine if the use of *ex ante dispatch analysis* is suitable when compared with other methods of estimating operating margin and revise the tool as appropriate. The revised tool should be available for consideration by the Board at its fifty-ninth meeting.

8. Available at: https://bit.ly/2u0TA8U.

ANNEX B

SIMULATIONS ON THE SIMPLE ADJUSTED OM OPTION, WHICH DO NOT INDICATE A PRIORI GAIN OR LOSS OF CARBON CREDITS[1]

TABLE B.1
Non-wind/solar energy generation projects[1]

Year	EF using OM dispatch *ex-post*, considering an uniform generation	EF using $EF_{adj\text{-}OM}$ *ex-ante*	EF using $EF_{adj\text{-}OM}$ *ex-post*	Comparison with other options, in relation to EF using OM dispatch *ex-post* [2]					
		EF_{CDM}	EF_{CDM}	*ex-ante* $EF_{adj\text{-}OM}$ 2011	*ex-ante* $EF_{adj\text{-}OM}$ 2010	*ex-ante* $EF_{adj\text{-}OM}$ 2009	*ex-ante* $EF_{adj\text{-}OM}$ 2008	*ex-ante* $EF_{adj\text{-}OM}$ 2007	*ex-post* $EF_{adj\text{-}OM}$
	tCO_2/MWh			%					
2012	**0.3621**	0.2855	0.3098	-39.8%	-32.8%	-44.1%	-33.2%	-44.7%	-14.5%
2011	**0.2010**	0.2179	0.2064		21.0%	0.7%	20.3%	-0.5%	2.7%
2010	**0.3113**	0.2432	0.2614			35.0%	-22.3%	-35.7%	-16.0%
2009	**0.1656**	0.2024	0.1895				46.1%	20.8%	14.4%
2008	**0.3153**	0.2419	0.2494					-36.5%	-20.9%
2007	**0.1875**	0.2001	0.2001						6.7%

Notes: [1] Equal weights for operating margin and construction margin.
[2] Comparisons of one-year *ex-ante* option can only be made with the options of later years.

TABLE B.2
Wind/solar power generation projects[1]

Year	EF using OM dispatch *ex-post*, considering an uniform generation	EF using $EF_{adj\text{-}OM}$ *ex-ante*	EF using $EF_{adj\text{-}OM}$ *ex-post*	Comparison with other options, in relation to EF using OM dispatch *ex-post* [2]					
		EF_{CDM}	EF_{CDM}	*ex-ante* $EF_{adj\text{-}OM}$ 2011	*ex-ante* $EF_{adj\text{-}OM}$ 2010	*ex-ante* $EF_{adj\text{-}OM}$ 2009	*ex-ante* $EF_{adj\text{-}OM}$ 2008	*ex-ante* $EF_{adj\text{-}OM}$ 2007	*ex-post* $EF_{adj\text{-}OM}$
	tCO_2/MWh			%					
2012	**0.4426**	0.3277	0.3641	-38.1%	-33.5%	-40.4%	-34.5%	-40.9%	-17.7%
2011	**0.2487**	0.2741	0.2568		18.4%	6.1%	16.6%	5.1%	3.3%
2010	**0.3967**	0.2946	0.3219			-33.5%	-26.9%	-34.1%	-18.9%
2009	**0.2087**	0.2639	0.2446				38.9%	25.2%	17.2%
2008	**0.4000**	0.2900	0.3012					-34.6%	-24.7%
2007	**0.2424**	0.2614	0.2614						7.8%

Notes: [1] 75% weight for operating margin and 25% weight for construction margin.
[2] Comparisons of one-year *ex-ante* option can only be made with the options of later years.

1. Annex B text prepared by Mauro Meirelles de Oliveira Santos.