From Project to Global Public Good: 
The Long Journey of the Plantar – World Bank Partnership

Christophe de Gouvello
Christoph Diewald
Fabio Nogueira de Avelar Marques

This case study presents an overview of a partnership between the World Bank and the Plantar Group in Brazil to deliver greenhouse gas (GHG) emission reductions across the pig iron supply chain in Brazil. The Plantar project in Minas Gerais, Brazil has been operational since 2000. To date, the project has delivered 4.0 million tCO₂e in certified emission reductions (CERs), verified during the period 2013-2016, through the expansion of eucalyptus plantations and the production of renewable charcoal for use as a “thermo-reducing agent” in the production of pig iron. The project helped to absorb carbon from the atmosphere, reduce methane emissions from the carbonization process in pig iron production and replace mineral coal, a GHG intensive fossil fuel as an industrial input.

This case study provides an overview of the project, its results, as well as important lessons learned around the role of partnerships in delivering innovation and impact. It analyses the way in which the Plantar Group and World Bank, together with other project stakeholders, forged an important relationship to deliver the project’s outcomes and create a significant basis upon which future emission reductions programs are built. Finally, it briefly reflects on how the Plantar Group became a leading actor in the ‘greening’ of a major industry, as well as an influencer to Brazil’s national climate policy through contribution to the global UNFCCC negotiations.

---

1 Christophe de Gouvello: Senior Energy and Climate Change Specialist, the World Bank.
Christoph Diewald: Senior Environment Consultant.
Fabio Nogueira de Avelar Marques: Director of Plantar Carbon.
The following persons have also directly or indirectly contributed to the elements presented in this paper:

From Plantar. XXX (to be completed)
# Table of Contents

Background and Project Origin ........................................................................................................... 1  
Brazil's Pig Iron Industry .................................................................................................................... 1  
Domestic and International Policy Developments ........................................................................... 2  
Project Overview ................................................................................................................................. 3  
Project Results .................................................................................................................................... 5  
  Component 1: Reforestation ............................................................................................................. 5  
  Component 2: Carbonization Process ............................................................................................... 6  
  Component 3: Renewable Charcoal Use ........................................................................................... 8  
  Best Practices in Environmental and Social Monitoring ................................................................. 8  
Outcomes and Impact .......................................................................................................................... 9  
  Effective Partnerships and Stakeholder Engagement ..................................................................... 10  
  Innovative Technology and Financing Modalities ......................................................................... 11  
  Climate Change Policy Development ............................................................................................... 12  
Summary of Lessons Learned .......................................................................................................... 13  
Future Outlook .................................................................................................................................... 15  
Conclusion .......................................................................................................................................... 16
Background and Project Origin

Brazil's Pig Iron Industry

Brazil is the world’s third largest producer of iron ore, and the fifth largest of pig iron. Pig iron production is heavily concentrated in the southeastern state of Minas Gerais, where iron ore is mined and has been an important industry since colonial times. Pig iron is an intermediate product in the iron and steel supply chain and can be used both as an input for the production of steel as well as for the production of foundry products, such as automotive parts and other iron-based appliances. The process of transforming iron ore to pig iron takes place under high heat in blast furnaces and requires the use of a thermos-reducing agent, such as coke or charcoal. The heavy use of charcoal in iron-ore production in states like Minas Gerais has had significant impacts on deforestation in the country.

This process of producing pig iron also results in carbon dioxide (CO₂) emissions and residual products such as slag. Within the industrial sector, iron and steel production are by far the largest source of Brazil’s greenhouse gas emissions (GHG). Pig iron production accounts for 27% of the national industrial emissions.

Traditionally, iron smelting in Brazil has used charcoal produced from wood in native forests. The rapid increase in iron and steel production since the 1950s required the import of mineral coal for use as a thermos-reducing agent. Most of Brazil’s pig iron production today (about 70%) occurs in large integrated mineral coke based iron and steel complexes; a smaller proportion (about 30%) is produced by numerous independent mills (see Box 1). Smaller, independent mills export a large part of their production or sell it to larger steel producers. Pig iron from large integrated complexes is used exclusively within the domestic steel production chain.

Harvesting native wood for charcoal in Brazil is prohibited by law. However, it still occurs to some degree. Currently, pig-iron mills, the principal agents in the iron and steel sector, meet their charcoal requirements from their own eucalyptus plantations (around 85% of required input) or source it from third-party plantations. Less is known about the source of charcoal of the many smaller pig iron mills.

Box 1: Pig Iron Production

Large-scale plants in Brazil primarily use coke as a thermos-reducing agent, whereas the smaller units use charcoal. This is largely because there is a technical limit to the size of blast furnaces using charcoal, due to the lower mechanical resistance of charcoal in the load mixture of the blast furnace. Furnaces using charcoal can reach substantive scales but not as significant as those using coke. This also limits the degree to which coke can be replaced by renewable charcoal as a reducing agent in the industry as a whole. Charcoal-based pig iron has a higher degree of purity (lower carbon, sulfur, and phosphorus content) than coke-based pig iron, and results in less residual ash and slag. Charcoal-based blast furnaces also apply a technology that injects pulverized charcoal into furnaces which has technological and environmental advantages to coke-based furnaces in terms of CO₂ abatement potential.

2 Another important Brazilian region for iron ore mining and pig iron production is the Carajás region in the Amazonian state of Pará. Pig iron smelting there has been based on charcoal from native rain forest woods.


4 Federal and Minas Gerais state legislation changed over time, but now essentially requires that large scale charcoal consuming industries use at least 80% of supply from planted forests.
**Domestic and International Policy Developments**

Significant domestic and international policy developments provided the enabling environment for a partnership between the Plantar Group and the World Bank. These include:

1) The change in Brazil’s tax incentives for domestic charcoal production in 1988

2) The development of a global greenhouse gas emission credit scheme through the **Clean Development Mechanism (CDM)** under the Kyoto Protocol in the late 1990s and early 2000s.

3) Linked to the CDM, the establishment of the World Bank’s **Prototype Carbon Fund**

In 1966, the Brazilian government promoted plantations of eucalyptus and pine trees through **tax incentives**, resulting in about six million hectares of new plantations. The company **Plantar Reflorestamentos**, located in Belo Horizonte, the capital of the State of Minas Gerais, was founded in 1967 to establish and manage eucalyptus plantations facilitated by the use of such tax incentives. Its first plantations were located near the town of Curvelo, in the center of the state. That area belongs to Brazil’s Cerrado biome, a vast savanna region composed of grasslands, shrubs and tree cover covering almost a quarter of Brazil’s territory.

In 1988, the tax incentives were discontinued which made it more expensive for companies to plant forests to supply charcoal to their mills. As a result, fewer new plantations in Brazil were established and the number of existing plantations went into decline, despite growing demand for pig iron. This led to growing scarcity of charcoal during the 1990s as existing plantations at the time were reaching the end of their rotation cycle. In the absence of new investments in plantations and charcoal production, coal coke is the most logical substitution and would have quickly been adopted as an alternative input. Plantar was one of the companies affected by the changes in tax policy and nearly ceased its planting activities in the 1990s.

In 1992, the **United Nations Framework Convention on Climate Change** (UNFCCC) was adopted in Rio de Janeiro. In 1997, it was complemented by the **Kyoto Protocol**, which commits its Parties by setting internationally binding targets for reducing GHG emissions. It also included a provision for a **Clean Development Mechanism**, which facilitates the implementation of projects to reduce GHG emissions in developing countries. Such projects can earn **Certified Emission Reduction (CER)** credits, each equivalent to one ton of carbon dioxide (CO₂), which can be counted towards meeting Kyoto targets. CDM is the first global, environmental investment and credit scheme of its kind, providing a standardized emissions offset instrument through CERs. The Kyoto Protocol entered into force in 2005.

Furthermore, in 1999 the World Bank established the **Prototype Carbon Fund (PCF)**, a private-public partnership that aimed to mobilize new and additional resources to address climate change and promote sustainable development. In addition, the PCF aimed to provide an opportunity to “learn-by-doing” in the development of policies, rules and business processes for the achievement of emission reductions through market-based mechanisms under the CDM and Joint Implementation Mechanism. The PCF was also designed to show how project-based emission reductions transactions and trade can promote and contribute to sustainable development and lower the cost of compliance with the Kyoto Protocol.

---

5 There is no available data to support this conclusion.
6 See Article 12 of the Kyoto Protocol on CDM. The CDM was actually proposed by Brazil at the Kyoto conference in 1997.
Overall, the scarcity of renewable charcoal supplies in Brazil due to the increased plantation costs, the establishment of the CDM through the Kyoto Protocol and the creation of the PCF laid the foundation for the development of the Plantar project.

**Project Overview**

In 2000, Plantar and the World Bank entered into a partnership to deliver the first project worldwide based on the Kyoto Protocol in the forestry sector, and a first-of-its-kind operation in the emerging global market for GHG emission reductions.

The Plantar project is a private undertaking of the Grupo Plantar, referred to hereafter as the Plantar Group or Plantar. Since 1985, the Plantar Group has been producing charcoal based pig iron from its plantations. Plantar has two furnaces for pig iron production, both in the town of Sete Lagoas in Minas Gerais. The Plantar Group integrates several companies, including the pig iron mill for eucalyptus plantations and charcoal production.⁷

Plantar recognized that both its plantations and its pig iron production could generate additional revenue for the company from the sale of CERs under the CDM. The basic idea for the project was as follows: first, eucalyptus plantations could mitigate climate change by absorbing CO₂ from the atmosphere and storing it in the trees (carbon sink), generating net-GHG removals. Second, charcoal made from planted eucalyptus would replace mineral coke as reducing agent in pig iron smelting, thus avoiding net CO₂ emissions. A third source of emission reductions, albeit smaller in magnitude, was from efficiency improvements in the process of producing of charcoal from eucalyptus wood, called carbonization. While yielding more charcoal from wood, this process reduced emissions of methane, a GHG which is much more potent than CO₂ in its global warming effect.

---

⁷ The Plantar Group includes also companies which manage third-party forests in several states, including for the production of construction timber and wood for furniture. More recently, the Plantar Group provides climate change advisory services to other firms and institutions particularly for the generation and handling of its own CERs.
1) **Reforestation**: To establish new plantations of high-yielding eucalyptus varieties to produce wood for charcoal production (originally with a target of 23,100 ha)

2) **Carbonization process**: To develop and apply improved technology to increase the carbonization efficiency of charcoal and reduce methane emissions in its production

3) **Renewable charcoal use**: To upgrade the commercial operation of Plantar’s pig iron plant, using charcoal from fuel wood produced under the project to substitute for the use of mineral-based coke in the pig iron production process

In addition, Plantar also initiated activities to regenerate native Cerrado vegetation on an area of pasture land.8

The total project duration was for 28 years. The crediting period for the CDM reforestation project (which formally began on November 10, 2000) was 30 years, whilst the crediting periods for the CDM carbonization project (which began in July 2004) and the industrial process (which began in December 2012), was seven years, renewable up to 21 years. Over the combined crediting periods, total emission reductions from the three CDM projects was estimated to be 12.9 million tons of CO₂ equivalent (tCO₂e) at the point at which the World Bank undertook appraisal of the overall project on April 1, 2002.


---

8 This was not aimed at generating CERs, but to enhance conservation of biodiversity.

9 The PCF ERPA initially included purchases of verified emission reductions from all three project components (CDM projects 2569, 1051, and 7577).
as Trustee of the BioCarbon Fund (BioCF)\(^\text{10}\). While the ERPAs created the opportunity to monetize the project’s carbon emission reductions, there was still a need to ensure that each project component met the standards set by the CDM. Therefore, each of the three project components needed to go through the processes required for CDM project registration, and later for CDM issuance of CERs. An important part of the process was to have a third-party independent assessment (by a Designated Operational Entity or DOE) of each proposed CDM project prior to request for registration (“validation”) and DOE assessments before each request for CER issuance (“verification). The CDM standard was required under these ERPA, so the purchase of emission reductions relied on successful completion of CDM processes\(^\text{11}\).

The project investments were not funded by a loan or grant from the World Bank. They were partially financed by equity, debt funding from the Minas Gerais State development bank and by a loan from Rabobank, an international private bank in Brazil. The Rabobank loan was secured by the expected revenues from the sale of CERs to the PCF (“monetization/securitization of receivables”), although there was a risk that such revenues might not materialize. Revenues from the sale of CERs were expected to enhance and maintain project feasibility and enable the project to be financially viable in the long term. This “carbon-based financing” was the first operation of its kind in the world.

In parallel to the preparation of technical studies and documentation that were required for the validation and registration of the three projects by the CDM Executive Board, the World Bank closely followed its operational requirements to ensure that environmental and social dimensions of the overall project were adequately treated. In addition, the World Bank required certification of Plantar’s forestry operations by the Forest Stewardship Council (FSC). FSC certification - though not required under the CDM – further contributed to the social and environmental sustainability of the project.

### Project Results

The Plantar project delivered 4.9 million tCO\(_2\)e CERs during the period 2000-2016 through expansion of planted eucalyptus plantations and the production of renewable charcoal for use as a thermo-reducing agent displacing coal coke in the production of pig iron. Further, Plantar became self-sufficient in the production of renewable wood and charcoal supply for its pig iron production. It became the first independent company in the world to produce pig iron based completely on the use of renewable charcoal, running its pig iron furnaces entirely without mineral coke.

#### Component 1: Reforestation

Implementation of the reforestation component began in 2000 and was concluded in 2009.\(^\text{12}\) Plantar succeeded in planting the targeted 23,100 ha of eucalyptus at four sites for renewable charcoal. Emission reductions were claimed from 11,642 ha in two of the four sites from the total plantation area. In the two

---

\(^\text{10}\) The BioCF ERPA signed on August 3, 2011 included purchases of CERs only from CDM project 2569: Reforestation as Renewable Source of Wood Supplies for Industrial Use in Brazil while the BioCF ERPA signed on August 3, 2011 included purchases of CERs from CDM project 7577: Use of Charcoal from Renewable Biomass Plantations as Reducing Agent in Pig Iron Mill in Brazil.

\(^\text{11}\) The PCF ERPA purchased verified ERs to mitigate uncertainty in CDM processes but required that the Trustee and Project Entity (Plantar) cooperate to ensure that project components become registered under UNFCCC rules with the goal of having the CDM issue CERs to respective project components.

\(^\text{12}\) Eucalyptus is generally planted and harvested in three seven-year cycles. After the first harvest, that is, after seven years, the trees can sprout (coppicing) and regrow again for a further seven-year period. This is repeated once more in year 14. The third and last harvest occurs in year 21. As new plantations are also staggered over a seven-year cycle, the last block is planted in year 7 and harvested in year 28.
other sites, areas were excluded from the project boundary due to CDM eligibility restrictions for reforestation projects.\textsuperscript{13} However, these areas were still eligible to be included in the boundary of the third CDM project component focused on producing pig iron from renewable charcoal instead of coke. The total planted area supplied the pig iron mill with its two blast furnaces up to a capacity of 240,000 tons of iron per year.

The project also increased the productivity of its eucalyptus plantations through rigorous selection of clones and improved silvicultural practices. Plantar established a research and development (R&D) program aimed at providing high-yielding eucalyptus clones, for steadily increasing yields. Field experiments using advanced scientific protocols and rigorous selection and propagation methods ensured the production of high quality seedlings for the plantations. Selected seedlings were propagated in greenhouses with electronic temperature and moisture controls and in field nurseries. The planting process involved minimum cultivation techniques, to minimize soil impacts and optimize water use. Fertilizers, herbicides and pest control substances were used strictly as per recommended silvicultural practices. Seedlings were monitored for survival and replanted where necessary. Fire monitoring is conducted in conjunction with fire-fighting brigades.

With the aim to promoting biodiversity conservation as a significant co-benefit, Plantar implemented a mosaic of eucalyptus plantations interspersed with areas of native vegetation, required by Brazilian forest law as “legal reserves” and “permanent protection areas.” Overall, the areas of native vegetation make up some 36\% of the plantation sites, and the productive parts about 64\%. The legally mandated areas of permanent protection serve as ecological corridors.

CERs for the net absorption of CO\textsubscript{2} through new eucalyptus plantations amounted to 4.072 million tons of CO\textsubscript{2} equivalent (tCO\textsubscript{2}e), issued by the CDM on April 13, 2012 for the period November 10, 2000 through November 9, 2010. The verified ERs from 11,642 ha of forest plantations was 67\% higher than originally estimated, due to a longer period to harvesting and higher mean annual increments. Of the 4.072 million tCO\textsubscript{2}e, Plantar sold about 1.5 million tCO\textsubscript{2}e via the PCF ERPA and another 1.1 million tCO\textsubscript{2}e\textsuperscript{14} via the BioCF ERPA.

**Component 2: Carbonization Process**

Plantar also succeeded in developing and implementing improved technology for reducing methane emissions in the charcoal-making (carbonization) process.

The new technology was the outcome of scientific research by independent carbonization experts, started and supported by Plantar at its plantations sites in response to the CDM incentive. The research concluded that there is a (negative)

\[ \text{Methane emissions in pig iron production} \]

Methane is released in the process of converting wood to charcoal. The impact of a ton of methane on global warming is much larger than that of a ton of CO\textsubscript{2}: Methane traps 72 times more heat in the atmosphere than CO\textsubscript{2} within a 20-year period, but it also leaves the atmosphere within 9 to 15 years, which is faster than CO\textsubscript{2}. As indicative of the scale of impact methane has on the atmosphere, the UNFCCC adopts a factor of 21 to compare the global warming impact of methane with CO\textsubscript{2}.

\textsuperscript{13} CDM did not permit the inclusion of areas where there had been forest plantations in 1989 or after, even if they were harvested well before the project started and even if new investments were required to plant new forests on the same land

\textsuperscript{14} The latter were actually “temporary CERs” (tCERs): tCER is a CER issued for an afforestation or reforestation project activity under the CDM which expires at the end of the commitment period following the one during which it was issued. They are considered temporary as UNFCCC holds that carbon sequestered from the agriculture, forestry, and other land use (AFOLU) sector may be released back to the atmosphere at any time (either through natural or man-made disturbances like fire or harvesting.
linear relationship between methane emissions and charcoal yield in carbonization. This means that the higher the charcoal yield from a given amount of wood, the smaller the level of methane emissions.

Plantar initially utilized around 2,000 brick kilns for carbonization. Although these were state of the art at the time, the kilns had a poor wood/charcoal conversion rate. The existing technology did not re-use volatile gases which subsequently resulted in more dangerous working conditions for workers because of the risk to exposure from toxic fumes.

To improve the process of carbonization, Plantar developed first a new circular beehive kiln, and then a much larger rectangular kiln, with automated (remote) temperature monitoring and rigorous temperature and combustion controls.

R&D conducted by Plantar found that temperature control is critical to optimizing wood carbonization and to increasing kiln efficiency (i.e. the charcoal to wood conversion rates, known as gravimetric yield). Improvements in gravimetric yield through temperature control and other measures enabled the reduction of methane emissions. A new seal system reduced emission of particulate material and volatile gases, improving workers’ health and safety conditions, and minimizing local impacts on air quality. As the new process demanded less biomass per ton of charcoal, it also allowed for more efficient land use – smaller forest areas for a given level of pig iron production.

**Picture 1 (Left): Large scale, high efficiency kilns**  
**Picture 2 (Right): Remote monitoring of temperature and combustion**

(Source: authors)

To carbonization component register the carbonization component as a CDM project, Plantar needed to first develop a CDM methodology to account for reductions of methane emissions based on the weight ratio between dry charcoal and dry wood. Methodology AM-0041\(^{15}\) was approved by the CDM Executive Board in November 2006. Next a project design document was submitted and independently validated. Validation confirmed (i) the previous traditional kiln design and operation was replaced by a newer design aimed at mitigating methane emissions; (ii) that the project measured and monitored the yield by weight in the charcoal-making process and used these values according to the methodology; and (iii) emission reductions would amount to 80,323 tons of CO\(_2\)e per year, with the existing rated capacity of carbonization units using pre-project technology, and (iv) that such emission reductions were additional. The

\(^{15}\) AM0041: Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production --- Version 1.0 (https://cdm.unfccc.int/methodologies/DB/B2SCH5WZLQYHTVSHQ4BIADMBCQ1P9U)
carbonization component was registered as a CDM project on August 9, 2007, with a project start date of July 2004, i.e. when CERs can start to be accounted for.

However, certain restrictions imposed by the CDM methodology approval process for the sake of conservativeness changed calculation parameters for the baseline after the project had already started to operate. This led to a drastic reduction of the amount of CERs to be issued. At the time, the methodology had become so conservative that Plantar concluded that it was not worth the cost to go through a verification process and Plantar generated no revenue for sales of emission reductions from this component16. Still, a significant outcome of this project component was the development and validation of a technology designed to reduce and monitor methane emission reductions. It also generated important social benefits for the health and safety of kiln workers. Both the efficiency-enhancing technology and the weight-based measurement pioneered by Plantar have been widely adopted in the charcoal industry in Brazil, generating a substantive spillover effect.

**Component 3: Renewable Charcoal Use**

Under the third CDM project which started on November 30, 2011, the use of renewable charcoal instead of coke in pig iron production contributed to a 75% reduction over the baseline emissions for the entire production chain from plantations through carbonization and smelting in the furnaces. Emission reductions from just absorption of carbon in the plantations (component 1) and the industrial process (component 3) resulted in about three tons of CO₂ for each ton of iron produced.

For the renewable charcoal use component, Plantar has generated ERs for three periods:

- 28 Dec 2012 - 31 Dec 2014: 465,967 tCO₂e17
- 1 Jan 2015 – 31 Jan 2015: 210,826 tCO₂e
- 1 Jan 2016 – 31 Jan 2016: 237,229 tCO₂e

This amounts to an average of about 228,505 tCO₂e per year, against a prior estimate of 329,000 tCO₂e. The shortfall is mainly due to the decrease in pig iron production relative to expectations at project design, because of a reduction in international demand in 2009 due to the global economic downturn at that time. Plantar sold all ERs generated from the component from 28 Dec 2012 to 31 Jan 2016 via the BioCF ERPA.

**Best Practices in Environmental and Social Monitoring**

Plantar has applied rigorous environmental and social standards to the integrated production process. Following Brazilian environmental legislation, all parts of the project were subjected to comprehensive environmental impact studies and met World Bank safeguards requirements.

**Environmental safeguards.** The projects obtained all necessary environmental licenses, as reviewed and issued by the state environmental agency. In addition, all the plantar projects were certified by the Forest Stewardship Council (FSC), which was a requirement under the PCF ERPA and have been recognized by the World Bank. All forest complexes include fauna and flora monitoring, using qualitative and quantitative parameters. The monitoring is conducted in accordance with FSC criteria, which includes

---

16 Under the PCF ERPA, Plantar and the World Bank agreed to replace the scheduled CERS from CDM project 1051 with CERS from CDM project 2569 and CDM project 7577.

17 This includes also the four last days of 2012.
survey and monitoring of threatened species, measures to restore natural habitats, and conservation of protected areas within the company’s property.

The industrial facility, with its two mini-blast furnaces and a 4.8 MW power plant, has a comprehensive pollution control system and adequate pollution abatement equipment; this includes including air pollution control equipment, toxic waste disposal facilities, water-cooling ponds, and water basins for collecting all industrial area runoff, in agreement with the license terms. The facility’s monitoring program includes noise, air emissions, and water quality. The industrial unit and the power plant’s emissions, effluents and wastes are properly controlled and mitigated, and are consistent with World Bank safeguards requirements.

Social responsibility. Plantar has units and staff dedicated exclusively to the well-being of its workers in the plantations, charcoal kilns and pig iron plant, and cooperates systematically with the local communities around the plantation areas. Plantar also promotes social, cultural and local economic development projects, aimed at increasing income generation of local communities (e.g. honey production within the plantation areas, employee-neighbor trade fairs where neighbors are able to sell their rural products to the project’s employees, etc.). Plantar undertakes frequent consultations with local stakeholders and maintains communication channels with local communities. Reports prepared for FSC certification specifically include consultations with stakeholders, incorporating both positive and negative feedback from stakeholders. Plantar issues a newsletter called *Jornalipto*, distributed to local and global stakeholders. The project also had large participation of women in the production of cloned sprouts. The Eucalyptus Urograndis hybrid cloned sprouts were used in the establishment of the project plantations due to their high productivity. The production of cloned sprouts in large-scale nurseries and localized irrigation systems were designed to enable more efficient use of water and other inputs.

**Outcomes and Impact**

The results of the Plantar project activities have important implications for future ER programs in the forestry sector and have had an impact on Brazil’s national approach to natural resource management and climate change.

The pioneer project generated significant know-how and experience that can be replicated. Plantar has also established the credibility of sustainable production of pig iron in the market and laid the basis for replication in Brazil and elsewhere. Plantar has demonstrated that high-quality emission reductions can be generated in the three stages of the production chain of pig iron. It has also shown that revenue can be obtained from these ERs under the CDM mechanism, and that such revenues can be used to obtain loan financing. The project has also demonstrated that it is possible for small to medium iron producers to become self-sufficient in producing charcoal in the iron-making process.

Plantar has been instrumental in its contribution to defining quality benchmarks for the production stages themselves, and for the measurement, validation and certification of emission reductions (or carbon absorption) under the CDM process, through the development of three new “methodologies”, that have been adopted by CDM.

The project has also demonstrated important co-benefits around income and employment resulting in poverty reduction and biodiversity conservation in areas that are among the poorest in Brazil, particularly those in the northern part of Minas Gerais state where the Itacambira plantations, the largest site of Plantar, are located. Plantar included native savanna vegetation in its “mosaic approach” to management and conservation, in part for reasons of compliance with national law. The project did not use or replace
any native vegetation in its production chain. There is thus an implicit conservation impact included in the integrated management of planted areas with interspersed native vegetation.

The impact of the Plantar-World Bank partnership is evidenced by the way in which the Plantar project achieved the following:

- Established effective partnerships for project initiation and implementation
- Delivered innovative technology and financing modalities, including pioneering methodologies for accounting of emission reductions to be utilized by future projects
- Linked project-delivery to policy influence, through contribution to Brazil’s national climate change agenda

**Effective Partnerships and Stakeholder Engagement**

The partnership between Plantar and the World Bank in this project was a critical factor to the project’s ability to effectively progress from project initiation through to implementation. The partnership also fundamentally supported the risk-sharing modality which was required to secure the investment needed.

Plantar’s role during initiation was to conceive the project idea, seek the necessary advice and support, contract requisite initial studies and lastly, form an internal team to work through the process of securing approval and UNFCCC CDM registration for the three components of the project. At the same time, the World Bank, through its Brazil Country Office and the carbon finance team in Washington, DC, played a highly supportive role for the project. World Bank staff support to the development of the underlying studies and requisite project documentation was instrumental to facilitate CDM approval of the project components. The World Bank task team worked very closely and effectively with Plantar in reviewing the design of the CDM projects and related methodologies, including with DOE and Plantar to conduct the validations and have the projects registered, and later monitored and verified to request issuance of CERs.

Further, the World Bank supported Plantar in managing external communications and broader stakeholder engagement around the project. This included responding to critiques from NGOs and the donor community. Two critiques of the project were related to the promotion of monoculture as well as the potential hydrological impacts of eucalyptus production. These interrelated critiques were brought forward by a few NGOs18 and donors during CDM Executive Board discussions at the UNFCCC prior to approval. NGOs also questioned the additionality of the plantations component. Some concerns also arose from within the World Bank itself as afforestation and reforestation projects have long periods of maturity that do not easily align within usual five-year project cycle.

Furthermore, the World Bank was also helpful in securing buy-in from initially reluctant UNFCCC officials to approve the project. For example, the World Bank played an intermediary role between the UNFCCC (along with the associated CDM Executive Board and its technical staff) and Plantar. At the time of project preparation and appraisal, the CDM had just become operational and, therefore, was in the process of formulating its rules, procedures and methodologies. There was frequent collaboration across CDM bodies, Plantar and the World Bank during the implementation of the project. The CDM eventually

---

18 While some international NGOs did not support the project’s inclusion under CDM and its funding from World Bank, the position of some national environmental NGOs (such as AMDA, the Minas Gerais Association for the Defense of the Environment) was quite different. AMDA and others were strongly opposed to the clearing of native vegetation for tree plantations but supported eucalyptus plantations in already cleared land as a measure of sustainable use of resources for industrial purposes.
adopted Planter’s proposal for the three new methodologies for baseline definitions and for monitoring emissions and emission reductions.

The World Bank also supported Planter to secure buy-in from federal and state government stakeholders. Brazil’s Federal Government had been a leading voice in the Kyoto process and the original proponent of the CDM mechanism. Nevertheless, the topic of tradable credits related to forestry activities was a politically sensitive topic for the Brazilian UNFCCC negotiators at that time. Further, there was initial reluctance from the Ministry of Science and Technology (MCT) to engage with the specific Planter project as well as to involve World Bank through the newly created PCF. Initially, Brazil did not participate in the PCF. The World Bank was, however, able to work with the Government to obtain support for the project. A letter of no-objection to proceed through validation of the project design document was obtained from the Brazilian Interministerial Commission on Global Climate Change, signed by the Minister of MCT and President of the Interministerial Commission on Global Climate Change in August 2000. In 2009, that Commission issued the letter of project approval to Planter.

In contrast to the Federal Government, the State Government of Minas Gerais supported the project and its intentions from the beginning, having already implemented a forestry project with a loan from the World Bank. While the removal of native vegetation in the state has affected vast areas over time, the state government has been taking a more conservative stance, protecting remaining native forests (within the framework of the national Forest Law), but also stimulating and regulating the use of already cleared areas for productive purposes, such as tree plantations. In 2010, the Secretary for the Environment and Sustainable Development of the state issued a letter to the “Designated Operational Entity” (TÜV Süd) supporting the project and its intentions, which also cited the support of sixteen Brazilian government and non-governmental organizations.

Through new financing modalities, discussed in the following section, the project was able to successfully spread and reduce investment risk which often inhibits the ability to secure long-term financing for sustainable land-use projects. For example, it was especially valuable for Planter that the PCF (and its investors) carried the “Kyoto risk”: revenues from CERs were dependent on a successful registration of the project, including development and approval of the methodologies that were used for the project, and subsequent ER issuances by the CDM. It was by no means certain at the time of signing the ERPAs that these revenues would definitively materialize. In 2009, the project received the award of best CDM project implemented in Brazil, from RMAI Magazine with the support of Brazil’s Ministry of Science and Technology and the Ministry of the Environment.

Innovative Technology and Financing Modalities

Plantar developed significant innovations in the iron industry of Brazil. The vertical integration of the three stages of the production chain under the CDM framework, i.e. production of wood, charcoal, and pig iron, were successfully implemented for the first time by Planter.

Plantar also developed and applied a technology to increase the efficiency of carbonization and reduce methane emissions. Improved kiln designs were adopted to better control the internal temperature in the process, including new large rectangular kilns that could be loaded mechanically and controlled remotely for temperature. A change in the way wood input is measured (i.e. from a basis of volume to that of mass) was an important part of this innovation. Together with the impressive increases in eucalyptus productivity, there was a resulting reduced need for forest area per ton of charcoal produced. Perhaps
as important as the productivity and emission gains have been, the benefits to Plantar’s workers in terms of occupational safety and health are also noteworthy.\textsuperscript{19}

The technology of \textit{injecting pulverized charcoal} into the blast furnaces enabled an increase in furnace efficiency and an overall increase in control over the process. It also allowed for the use of ground charcoal generated in handling and transport, which were previously not used or were sold for insignificant prices. The technology ultimately optimized the use of charcoal, thereby requiring a smaller area of forest per ton of iron to be used as input.

Obtaining appropriate (long-term) \textit{loan financing for plantations and for pig iron production} was quite difficult at the time. Plantar not only demonstrated that it was possible to use the carbon value to obtain upfront private loan financing for such investments to be made, but also that future (expected) CER revenues could be used as security. In fact, the nature of that revenue was essential for Plantar to secure the loan from Rabobank, an international bank specialized in funding sustainable agriculture.

The loan financing was important as there was a long wait time between when the initial investments were required for the project and when revenue was generated from the sale of CERs. The up-front loan from Rabobank was structured in such a way that the repayment schedule was aligned with the schedule of expected receipt of revenue from sale of CERs. This type of loan financing is called monetization and securitization of receivables. When PCF made the payment for the CERs purchased from Plantar, the payment was transferred directly to Rabobank which served as the loan re-payment for Plantar. This arrangement helped reduced the potential risks from foreign exchange rates. Additional revenue from the sale of CERs has helped the Plantar obtain additional sources of debt financing mentioned above.

This arrangement has also reduced Plantar’s risk domestically, by increasing confidence of lenders, as exemplified by the lessening of constraints on long-term financing from local institutions such as the Minas Gerais Development Bank (BDMG). The ERPA signed with the PCF played a role as potential collateral support funding arrangements with the BDMG. The Plantar project would have faced severe difficulties to be implemented without the CDM.

Overall, the investment benefited significantly from the inclusion of CDM carbon credits and there was an enabling effect, both from a profitability and cash-flow point of view. Plantar states that it would not have undertaken the project without this component.

\textbf{Climate Change Policy Development}

As a result of its unique experience and thorough understanding of both regulatory issues and implementation challenges with the CDM, Plantar became an active participant in the domestic debate on climate change policy at the national, state and sector level. Plantar was repeatedly invited to be part of the Brazilian delegation to UNFCCC meetings and actively contributed to the positions and proposals of the Brazilian government at international fora, especially the ones related to LULUCF and the industry. At the Copenhagen Conference of the Parties (COP) in 2009, Brazil voluntarily committed to reduction of GHG emissions (between 36.1\% and 38.9\% relative to a base case scenario through 2020). Shortly thereafter, these intentions became federal law, in the National Policy on Climate Change (Law 12.187 of 2009). Brazil proposed and the UNFCCC registered ten \textit{National Appropriate Mitigations Actions (NAMAs)}. The regulation of the law (Decree 7390 of 2010) specifically mentions “the increase in the use of vegetal charcoal from planted forests and improvement in the efficiency of the carbonization process”

\textsuperscript{19} In contrast to this co-benefit, it is possible there are counteracted by reductions in labor demand. Further studies and data analysis would need to be conducted.
– a direct reference to the Plantar project. The decree also stipulated the elaborations of five sector plans, one of which is devoted to reducing emissions in the iron and steel sector, through the sustainable production and use of renewable charcoal.20

In the state of Minas Gerais, a state law was approved in 2009 which, among other things, obliges large users of wood and timber to obtain their 95% of their supply from planted forests by 2018. One important clause of the law requires the government to stimulate the use of CDM and other carbon trading schemes, either through carbon stock enhancements or energy substitution, to generate additional incentives for new forest plantings.

In 2015, with the COP 21 Paris Agreement and with submission of Intended Nationally Determined Contributions of Brazil (INDC),21 Brazil committed to a 37% reduction of GHG emissions by 2025 from a 2005 baseline scenario. Discussions began in Brazil how to implement its INDC, including in strategic sectors such as the production of charcoal based iron. Other donor-funded initiatives have followed, building from the experience of the Plantar project. For example, an initiative funded by the Global Environment Facility and implemented by UNDP, together with the Minas Gerais state government and two federal ministries, is currently supporting the development of a sustainable, low-carbon production chain for iron and steel. The project provides incentives for increased efficiency in carbonization and seeks a favorable institutional and regulatory environment for the use of vegetal charcoal by the pig iron, steel and ferro-alloys.22 The project concept originated by Plantar has thus found a firm place in the Brazilian policy on mitigation of climate change.

The experience from the Plantar projects under CDM and its understanding of the UNFCCC and the regulatory processes, has been rewarding as Plantar currently provides advice and assistance to other companies including the public sector through its consulting arm, Plantar Carbon. Plantar Group provides advisory services on matters of climate change, mitigation, and sustainability not only in forestry, but also in other sectors such as mining, chemical, pulp and paper, iron and steel and others in Brazil. Plantar Carbon proposes solutions based on scientific research and innovation, reconciling economic competitiveness, climate protection and sustainability. In 2016, Plantar Carbon was accredited as an official education and capacity building partner of the Carbon Disclosure Project, an organization based in the United Kingdom which runs a global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts.23

**Summary of Lessons Learned**

**Managing uncertainty and implementation delays.** The project took much longer to earn the expected revenue from CERs than initially scheduled, although investments (via the pioneering loan provided by Rabobank) were made almost exactly as programmed. The project depended on interactions outside of the ERPA with key CDM bodies (Secretariat, Methodology Panel, and Executive Board) that - at the time of the World Bank’s project preparation and appraisal - were just starting work on its rules, procedures and methodologies. The entire process of CDM project formulation and processes (e.g., validation,


21 The INDC informed by Brazil to UNFCCC do not mention the iron and steel sector specifically but include “restoring and reforesting 12 million hectares of forests by 2030, for multiple purposes”.

22 Project title: Production of Sustainable, Renewable Biomass-based Charcoal for the Iron and steel Industry in Brazil

23 [https://www.cdp.net/en](https://www.cdp.net/en)
registration, verification, and issuance) was still highly uncertain. The delays in approval and subsequent generation of ERs were thus largely due to the complexities of the development of CDM methodologies and CDM process. The PCF ERPA however allowed for the generation of revenues before the formal approval of the projects by the CDM, since payments were made on the basis of verified (not issued) emission reductions (VERs), and this helped to mitigate delays to some extent.

Nevertheless, staying abreast of the rapid and expansive development of CDM methodologies, templates, standards, procedures and guidelines proved challenging not only for Plantar, but for contracted technical experts and World Bank staff. It required constant learning, innovation, and capacity building. The first registration of the plantar projects under CDM occurred only on July 21, 2010, eight years after the ERPA agreement was signed with PCF.

**Generating positive “spillovers” in the form of co-benefits.** Pursuit of objectives related to mitigation of climate change, such as the generation and sale of carbon credits may have substantial positive spillover effects in the form of other economic and environmental benefits. Plantar and the World Bank were both persistently engaged, through research and innovation, in improving the productivity of its eucalyptus stands, while also helping conservation of native ecosystems. In focusing on improving the efficiency of the carbonization process, Plantar and the World Bank also strived to deliver the triple benefits of 1) higher carbon yields, 2) reduced methane emissions and 3) healthier working conditions all while improving the productivity of the pig iron smelting process based on renewable charcoal. All this helped to increase financial returns at the same time as increasing the efficient use of natural resources and reduced GHG emissions.24

There was significant initial concern over the potential negative environmental impacts of supporting monoculture production and water resource-intensive agricultural practices. Specifically, there was significant opposition among international NGOs and also from within the World Bank to eucalyptus plantations as monocultures and excessive users of groundwater. The hydrological impact has been one of the most controversial aspects of eucalyptus plantations, based on the hypothesis that plantations of fast-growing tree species tend to use more water than primary forests, reducing the amount of water available to downstream areas. Plantar, with the assistance of a federal university, is currently conducting a water balance study in one of its complexes to assess the impact of eucalyptus plantations on water resources, the results of which are not yet available.

**Increasing appetite for piloting new approaches.** The World Bank took risks in promoting the Plantar project under substantial uncertainty. This paid off in opening up new spaces for private ventures and supporting new public policies that promote environmental objectives. At inception, the World Bank had limited experience in designing this type of operations but benefited from the coordination and consultations with parallel projects in Latin America. Project preparation took into account results and lessons of the Minas Gerais Forestry Development Project which had been funded by a World Bank loan in the 1990s that supported the increase of wood and charcoal production for industrial use and aimed to reduce degradation of native forests in Minas Gerais State.

The project was started at a time when returns in the form of carbon credits could be expected but were by no means guaranteed. Additionally, the project including the World Bank task team also faced challenges due to the lack of applicable and approved methodologies at the time of project design.

---

24 The eventual failure of getting credit for reduced methane emissions notwithstanding
followed by a cumbersome approval of the developed methodologies, frequent changes in UNFCCC/CDM rules, and fluctuations of the market price for CERs.

Without the added incentive from ER revenues, Plantar would not have planted as much eucalyptus as it did, nor would it have engaged as significantly in the research and innovation activities mentioned above. Likewise, it would not have stimulated other firms to adopt methodological and technological advances in a similar vein. Overall, the demonstration effect which clearly contributed to the development of several national policies would not have occurred.

The strong support by the World Bank also helped to secure needed buy-in from the Brazilian government, which then led to the increase of renewable charcoal in pig iron production as one of its strategies for climate change mitigation.

**Combining bottom-up and top-down approaches to project design.** The project emerged from a bottom-up idea born by Plantar and supported by the World Bank, as opposed to a top-down result of public policy. At the same time, the project structure was developed in a way which made use of incentives derived from a new global framework, set out in the Kyoto Protocol through the CDM - and, by association, the PCF set up by the World Bank. Without the establishment of these mechanisms, the space would not have been created to allow Plantar to incubate its project idea. Both had to be in place for climate change mitigation to bear fruit.

**Forging trust across partners.** The relationship of trust between the World Bank and the project entity was paramount. It was also by no means guaranteed from the outset. In the situation when the project was first identified and formulated, when Plantar entered into the ERPA agreement with the PCF, the World Bank placed progressively full confidence in Plantar as a reliable, highly committed partner; Plantar similarly trusted the World Bank’s long-term commitment to the initiative. The project would not have become successful without this mutual trust.

**Future Outlook**

The future of the Plantar project and its ability for replication is uncertain. The last ERPA with the BioCF will expire in December 2018, when Plantar will have delivered its 1.2 million tCO$_2$e of CERs from the industrial project component. Considering that the project has the potential of continuing for two more crediting periods under the CDM or a potential new mechanism, Plantar is likely to continue to produce iron with charcoal derived from its eucalyptus plantations. However, it is still early to tell what exactly the context will be when the BioCF ERPA expires.

There are a number factors which influence the risks and opportunities associated with the expansion of the project’s approach to pig iron production:

- **The domestic economic situation of the iron sector** in Brazil remains bleak, with low pig iron prices, low domestic and international demand, and slack capacity in the sector. As a result, the pig iron industry in Brazil is currently experiencing a situation somewhat similar to the one observed at the beginning of the project: although planted forest stocks have increased in absolute terms and more than 80% of the charcoal produced is currently used in blast furnaces, new investments in plantations have been severely affected in recent years. This is not yet an issue for the charcoal supply chain because pig iron facilities are currently running on approximately 40% of their installed capacity. However, once full operating capacity resumes, the supply of renewable biomass will again become an issue. The lack of renewable charcoal from sustainable plantations will lead to more GHG emissions, either from increased use of mineral coal coke or from the use of non-renewable charcoal,
despite being now further constrained by legislation. Carbon finance could still play a decisive role to prevent such downturn if properly designed.

- Currently, producers of pig iron do not fetch better prices if their iron is “greener” than that of other producers. They could benefit from carbon revenues, but the nature and structure of the market for carbon emissions, “post-Kyoto” and after adoption of the Paris Agreement is less clear than it was before. In addition, the price of carbon after the crash of the carbon market, had stagnated at low levels, much lower than it was in the early years of emissions trading, although this has recently changed. This is due to both an oversupply of emission allowances by the European Emission Trading Scheme, but also to an oversupply of CERs by the CDM.

- Linked to the market emissions market point above, there are so far, no national policies in Brazil that would provide a disincentive for GHG emissions, either through a carbon tax or cap-and-trade scheme. Under such policy, coke-based pig iron would be at a disadvantage compared to charcoal-based pig iron. Sustainable charcoal would thus depend exclusively on some form of incentives (a “carrot” versus a “stick”).

Developing countries can no longer claim credits for emission reductions under CDM, if they claim the same reductions towards national reduction goals. It is an “either – or” situation. Nevertheless, considering the much more ambitious national targets pledged under the Paris Agreement, there could be a higher demand for certified units. The prospect that CERs or other carbon units would be accepted by domestic carbon pricing schemes in developing countries are also increasing in many parts of the world: for instance, in Latin America, Colombia already decided to do so under its new carbon tax scheme. Brazil is currently assessing different options for a national carbon pricing scheme, including the possibility of establishing an offset mechanism.25

These initiatives and many others across the world signal that there might be a renewed role for carbon crediting in the future.

Plantar is currently working on a new program in the south of Brazil. It consists of the involvement of many smallholders in (a) the establishment of wood plantations and (b) the restoration of illegally denuded areas by planting of native species.

## Conclusion

Overall, the Plantar project activity and its diverse range of internal and external results have been an important experience over its 17-year experience. The following groups of outcomes have been highlighted in this case study:

- **Operational level**: The project has generated innovative results in an industry that has been sensitive from the point of view of sustainable development for several decades. Substantive milestones have been achieved in terms of reforestation for industrial purposes, worldwide innovation in the carbonization process and its sustainable use in the production of pig iron as mitigation and sustainability drivers. The carbonization efficiency-enhancing technology was made publicly available and adopted by most charcoal producers in Brazil. It is worth noting that Plantar is not a large company, which demonstrates the power of carbon finance in the transformation of mid-sized agents.

- **Methodological level**: The development of CDM methodologies has been quite challenging but it also illustrates how instrumental the case was in the creation of a global regulatory framework.

---

25 Through the Partnership for Market Readiness (PMR) program, the World Bank is currently supporting the Brazilian government in designing and evaluating potential carbon pricing instruments aimed at facilitating the achievement of the country’s NDC target, including the possibility of offsets from reforestation projects.
built upon multilateral consensus. The methodological legacy, including its worldwide
applicability, is a result per se. Several projects have since then been submitted to the CDM
utilizing these methodologies. This outcome goes beyond the technical level since it has been
part of a long-term process of “legitimacy building” at the multilateral level, facing barriers which
were often placed beyond simple rationality.

- **Institutional level:** In addition to production processes, the project also required the creation of
new institutional arrangements, which included, among other things:
  - New internal and external teams, an innovative contract (ERPA) for the purchase of ERs
    from Plantar by the World Bank as trustee of the PCF,
  - Innovative securitization agreement with a financial partner (Rabobank),
  - CDM methodological requirements integrated with production quality management
    processes,
  - Practices for the integration with stakeholders at the global and local levels,
  - FSC certification in production practices (the only company certified in the pig iron
    integrated supply chain) *inter alia*.

- **Policy level:** Understanding policymaking at the national and multilateral (UNFCCC) level played
a crucial role in project implementation, since these considerations framed the broader regulatory
framework within which direct project components operated. The project was also able to
provide substantive bottom-up and operational experience to the development of policy in Brazil
and abroad. Had it not been for the sharp fall in the CER prices, especially attributable to the
demand side, the project replication potential could have played a substantive role. There are still
important lessons and foundations upon which future initiatives can build.

---

26 There were three other projects submitted to CDM for substitution of coke by sustainable charcoal in Brazil, using the same
methodology as the Plantar project. Project 8238: Use of Charcoal from Renewable Biomass Plantations as Reducing Agent in
Pig Iron Mill of ArcelorMittal Juiz de Fora, Brazil. Project 9131: Use of charcoal from renewable biomass originated from forest
plantations for the production of primary iron in Vallourec & Mannesmann do Brasil. Outside Brazil, there are other
 afforestation or reforestation projects registered by CDM that use the same methodology as first developed by Plantar. These
 include for example, Project 4595: Forestry Project in Strategic Ecological Areas of the Colombian Caribbean Savannas,
 Colombia; Project 4957: Securitization and Carbon Sinks Project, Chile; Project 4127: Reforestation of grazing Lands in Santo
 Domingo, Argentina.