

From Project to Global Public Good:

The story of the Plantar Group – World Bank Partnership

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Executive Summary

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 analyzes the way in which the Plantar Group and the 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 a relevant contributor to Brazil’s national climate policy through active engagement in the global UNFCCC regime.

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Background and Origin of the Project

The private company Plantar Group and the World Bank formed a successful partnership in 2000 that would become a first-of-a-kind operation in the emerging global market for greenhouse gas emission reductions. This section describes the Brazilian pig iron industry, the international development of certified emission reduction (CER) credits to help finance emission reduction projects, and the trajectory resulting in the Plantar Group – World Bank partnership.

Brazil's Pig Iron Industry

Brazil is the world's third largest producer of iron ore, and the fifth largest producer of pig iron. Since colonial times, pig iron production has been heavily concentrated in the southeastern state of Minas Gerais, based on the iron ore mined there.¹ Pig iron is an intermediate product in the iron and steel supply chain that can be used as an input to produce steel and for the production of foundry products, such as automotive parts. The process of transforming iron ore into pig iron takes place under high heat in blast furnaces. Coke, a fuel with a high-carbon content and few impurities, usually made from low-ash, low-sulphur, is often used as a thermo-reducing agent. However, in Minas Gerais, charcoal is also used and the State became the world's largest producer of charcoal.

The pig iron production process results in emissions of carbon dioxide and residual products (slag). Within the industrial sector, iron and steel production are by far the largest sources of Brazil's greenhouse gas emissions. Pig iron production alone accounts for 27 percent of national industrial emissions.²

Traditionally, and especially in pig iron production, Brazilian iron smelting used charcoal. Charcoal from native forests was a major source of charcoal supply. Over time, especially after fiscal incentives in 1967, as explained henceforth, eucalyptus plantations were also established to provide part of the supply. The rapid increase in iron and steel production since the 1950s required importing mineral coal to create coke.

Most of the current Brazilian pig iron production (some 70 percent) occurs in large, integrated iron and steel complexes; with a smaller part (about 30 percent) produced by numerous independent mills (see Box 1). The smaller, independent mills

Box 1: Pig Iron Production

Large-scale plants in Brazil primarily use coke as a thermo-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.¹

¹<https://www.sciencedirect.com/science/article/pii/S2238785414000489>

¹ 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 forests.

² <http://seeg.eco.br/wp-content/uploads/2016/09/WIP-16-09-02-RelatoriosSEEG-Sintese.pdf>

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.

Although deforestation of native wood for charcoal is now prohibited by law, it occasionally still occurs.³ Currently, most large iron and steel producers obtain their charcoal requirements from their own eucalyptus plantations (85 percent) or purchase it from third-party plantations. Less is known about the sources of charcoal of the many smaller pig iron mills. However, since about 2009, the pig iron industry has been suffering from weak demand, both domestically as well as in the global market, and from low use of capacity.

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; and
- 3) The establishment of the World Bank's **Prototype Carbon Fund** (Linked to the CDM).

In 1966, the Brazilian government established tax incentives to promote forest plantations of eucalyptus and pine, resulting in about 6 million hectares of new plantations. The company, originally known as Plantar Reflorestamentos, located in Belo Horizonte, the state capital of Minas Gerais, was founded in 1967 to establish and manage eucalyptus plantations, making use of the tax incentives. Its first plantations were located near the town of Curvelo, in the center of the state in Brazil's Cerrado biome, a vast savannah of grasslands, shrubs, and tree cover, which encompasses almost a quarter of Brazil's territory.

In 1985, Plantar Group⁴ began to produce pig iron using charcoal produced in its plantations. Two furnaces were established in the town of Sete Lagoas in Minas Gerais.

Three years later, in 1988, tax incentives were discontinued which made it difficult for companies to continue planting forests to supply charcoal mills. As a result, the establishment of new plantations in Brazil declined, and harvested plantations were not able to be replaced quickly enough to meet the demand of the pig iron industry. This led to growing scarcity of charcoal during the 1990s. Thus, Plantar Group nearly ceased its planting activities in the 1990s. In the absence of new investments, coke would have quickly become the only option for pig iron production.

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,⁵ which commits its Parties by setting internationally binding targets for reducing greenhouse gas (GHG) emissions. Importantly, it also included a provision for a Clean Development Mechanism (CDM, Article 12 of the Kyoto Protocol), which facilitates the implementation of projects in developing countries to reduce greenhouse gas emissions.⁶ Such

³ Federal and Minas Gerais state legislation changed over time, but now requires that large-scale charcoal-consuming industries use at least 80 percent of their supply from planted forests.

⁴ Plantar Group also includes companies which manage third-party forests in several states, including for the production of construction timber and wood for furniture. It also provides climate change advisory services to other firms and institutions particularly for the generation and handling of its own CERs.

⁵ The Kyoto Protocol entered into force in 2005.

⁶ CDM was actually proposed by Brazil at the Kyoto conference in 1997.

projects can earn Certified Emission Reduction (CER) credits, each equivalent to one ton of carbon dioxide (CO₂), which can be counted toward meeting Kyoto targets. These credits can be earned, but also bought and sold on a market exchange. CDM was the first global, environmental investment and credit scheme of its kind, providing a standardized emissions offset instrument – the CER.

In 1999, the World Bank established the Prototype Carbon Fund (PCF), a private-public initiative with the objectives of combating climate change, and promoting the World Bank's tenet of sustainable development. The PCF aimed to offer a "learning-by-doing" opportunity in the development of policies, rules, and business processes for generation of tradable emission reductions (ERs) from projects, through market based mechanisms under CDM.

The World Bank – Plantar Group Partnership

Plantar realized that both its plantations and its pig iron production could generate additional revenue from the sale of CERs under the CDM. The basic idea is simple: on the one hand, eucalyptus plantations contribute to mitigation of climate change by absorbing carbon dioxide from the atmosphere and storing it in the trees (carbon sink), generating net GHG removals. On the other hand, charcoal made from planted eucalyptus can replace mineral coke as the reducing agent in pig iron smelting, thus avoiding net CO₂ emissions.

A third source of emission reductions (of lesser magnitude, but still important) was improvements in the process of producing charcoal from eucalyptus wood, called carbonization. This process can be made to be more efficient, yielding more charcoal from wood, while reducing emissions of methane, a GHG which is much more potent than CO₂ in terms of its climate change effects.

With the vertically integrated operations of the Plantar Group, the scarcity of renewable charcoal supplies, the existence of the Kyoto Protocol and the CDM, and the creation of the PCF, the

Box 2: Baseline measurements for emission reductions in pig iron production

Emission reductions under the CDM are measured against a baseline. The CDM Rule Book defines the baseline of a project as "the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity." Further, this scenario "shall cover emissions from all gases, sectors and source categories ... within the project boundary." The baseline for greenhouse gas absorption (which may be thought of as negative emissions) is a scenario where non-forest land used for eucalyptus planting (pastures, grasslands) remains without tree cover. In the case of pig iron smelting, the baseline is the use of coke made from (imported) mineral coal as a reducing agent. In charcoal production, the baseline would be the methane emissions without improvements of the carbonization technology.

foundation was laid for the conception of a project to take advantage of the CDM. The Plantar project would become a first-of-a-kind operation in the emerging global market for GHG emission reductions. Plantar was to become the world's first project based on the Kyoto Protocol in the forestry sector. Thus in 2000, Plantar Group and the World Bank entered into a successful partnership, which lasts to this day.

The World Bank and the PCF had limited experience at the time in designing this type of operation, but benefited from consultations with parallel projects being developed in Latin America. For example, project preparation considered lessons of the Minas Gerais Forestry Development Project, which had been funded by a World Bank loan in the 1990s to support the increase of wood and charcoal production for industrial use, and aimed to reduce the degradation of native forests in Minas Gerais.

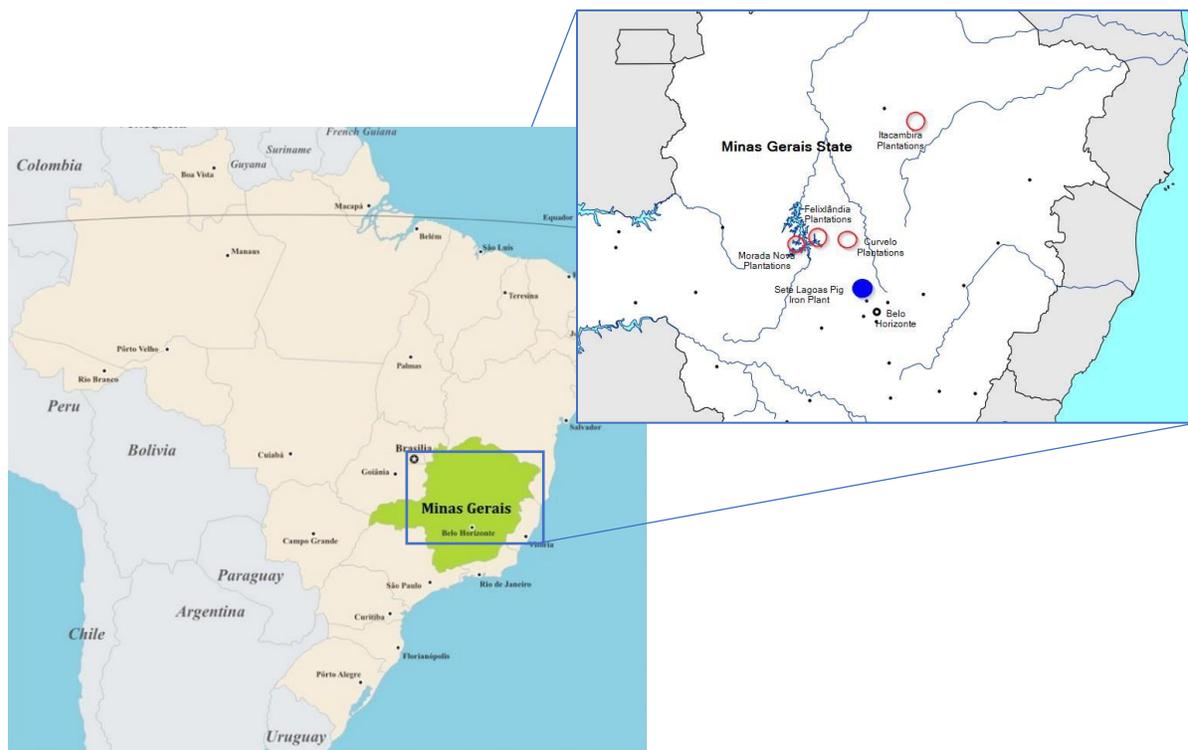
The Project

The Plantar project was a private undertaking of the Plantar Group aimed to “reduce greenhouse gas emissions and the enhancing of anthropogenic removal of GHG by sinks,” through:

- **Reforestation** for the sustainable production of wood for charcoal production;
- **The carbonization process** for the reduction of methane emissions resulting from charcoal production; and
- **Use of renewable charcoal** for the displacement of mineral-based coke in its pig iron plant.

The above three components were established as three individual, but interrelated sub-projects⁷. Given this, the overall project comprised of establishing new plantations of high-yielding eucalyptus varieties to produce wood for charcoal production (originally with a target of 23,100 hectares), developing and applying improved technology to increase carbonization efficiency and reduce methane emissions, and upgrading and operating the Plantar Group’s pig iron plant, using charcoal produced by the reforestation component as a substitute for coke in the pig iron production process. The project also included the regeneration of native Cerrado vegetation on an area of pasture land.⁸ This was not aimed at generating CERs, but to enhance the conservation of biodiversity.

Figure 1: Location of the Project Sites in Minas Gerais State, Brazil



⁷ CDM/UNFCCC project references and links: (a) [Project 2569](#): Reforestation as Renewable Source of Wood Supplies for Industrial Use in Brazil; (b) [Project 1051](#): Mitigation of Methane Emissions in the Charcoal Production of Plantar, Brazil; and (c) [Project 7577](#) : Use of Charcoal from Renewable Biomass Plantations as Reducing Agent in Pig Iron Mill in Brazil.

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

The first dedicated plantation for the reforestation component started in 2000 and planting operations were concluded in 2009.⁹ The original project was completed with the planting of new eucalyptus stands, investments to reduce methane emissions, production of pig iron with renewable charcoal, as well as some efforts to regenerate a parcel of native Cerrado vegetation.

The World Bank and Plantar Group then signed letter of intent. On September 4, 2002, the Plantar Group signed an “Emissions Reduction Purchase Agreement” (ERPA) with the World Bank as Trustee of the PCF.¹⁰ The Plantar Group entered into two additional ERPAs on August 3, 2011, with the BioCarbon Fund,¹¹ also with the World Bank as Trustee. Through the ERPAs, the Plantar project committed to deliver CERs, and the two carbon funds committed to buy the CERs from Plantar. For CERs to be issued by CDM, the three sub-projects/components had to be validated, registered, and verified. Validation and verification are performed by independent third parties (Designated Operational Entities – DOE) which are accredited by CDM.

The “crediting period” for emission reductions is 30 years for the reforestation component (starting in November 2000). For the carbonization component (starting in July 2004) and the industrial process (starting in December 2012), the crediting period was 7 years, renewable up to 21 years. At appraisal (April 1, 2012), total emission reductions from the three components of the Plantar project were estimated at 12.9 million tons of CO₂ equivalent (tCO₂e).

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 an international private bank (Rabobank of Brazil). The Rabobank loan was secured by the expected revenues from the sales 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 line with its environmental and social safeguard policies, the World Bank insisted that the environmental and social dimensions of the project were adequately considered in the preparation of studies and documentation for the approval of the project by the CDM. Although it was not required for CDM approval, the World Bank required certification of the Plantar Group’s forestry operations by the Forest Stewardship Council (FSC) as a condition in the ERPAs to indicate the social and environmental sustainability of the project.

⁹ Eucalyptus is generally planted and harvested in three seven-year cycles. After the first harvest, that is, after seven years, the trees are allowed to sprout (coppicing) and regrow again for another 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.

¹⁰ The PCF ERPA initially included purchases of verified emission reductions from all three project components (CDM projects 2569, 1051, and 7577).

¹¹ 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.

The Results

The Plantar project delivered 4.9 million tCO₂e CERs during the period of 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 entirely on the use of renewable charcoal, running its pig iron furnaces entirely without mineral coke. Plantar Group was not able to generate CERs from the carbonization component due to regulations in CDM that resulted in reduction of the originally estimated volume making it cost inefficient to proceed with verification.

Reforestation, and use of renewable charcoal for pig iron production

The Plantar Group succeeded in planting the expected areas of eucalyptus for renewable charcoal: 23,100 hectares at four sites. ERs from the reforestation component were claimed from only 11,642 hectares, in two of the four sites. Areas in the two other sites were excluded from the “project boundary” of the reforestation project submitted to CDM due to CDM eligibility restrictions for reforestation projects.¹² These areas were, however, eligible and included in the boundary of the CDM project producing pig iron from renewable charcoal instead of coke. The total planted area could supply the needs of the pig iron mill’s two blast furnaces, with a capacity of 240,000 tons of iron per year.

From the start of the project, the Plantar Group succeeded in steadily increasing the productivity of its eucalyptus plantations through rigorous selection of clones and improved silvicultural practices. It established a research and development program intended to provide high-yielding eucalyptus clones, for steadily increasing yields. Field experiments using advanced scientific protocols, and rigorous selection and propagation methods, assured 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. Minimal cultivation techniques were used that mitigated soil impacts and optimized water use. Fertilizers, herbicides, and pest control substances were used strictly as per recommended silvicultural practices. Survival of seedlings were monitored and seedlings were replanted where necessary. Fire monitoring was conducted in conjunction with fire-fighting brigades.

To promote conservation of biodiversity in its plantations, the Plantar Group also 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, native vegetation makes up about 36 percent of the plantation sites, compared with a productive area of 64 percent. The legally mandated areas of permanent protection serve as ecological corridors.

The plantations created during the project made the Plantar Group self-sufficient in renewable wood and charcoal for its own pig iron plant. Its furnaces were adapted to receive pulverized charcoal by injection for iron smelting. Plantar managed to run its pig iron furnaces entirely without mineral coke. It became the first independent company in the world to produce pig iron based entirely on the use of renewable charcoal.

¹² 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.

Reduction of methane emissions

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

This new technology was the outcome of scientific research by independent carbonization experts, started and supported by the Plantar Group at its plantations in response to the CDM incentive. The higher the charcoal yield from a given amount of wood, the smaller the emission of methane. The research proved that there is a (negative) linear relationship between methane emissions and charcoal yield in carbonization.

The Plantar Group initially had around 2,000 brick kilns for carbonization, which were state of the art at the time, but still had a poor wood-charcoal conversion rate, due to lower control of the combustion process. Plantar Group first developed a circular beehive kiln, and then a much larger rectangular kiln, with automated (remote) temperature monitoring and rigorous temperature and combustion control.

Box 3: 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 climate change is much larger than that of a ton of CO₂: Methane traps 72 times more heat in the atmosphere than CO₂ within a 20-year period, but it also leaves the atmosphere within 9 to 15 years, which is faster than CO₂. As indicative of the scale of impact methane has on the atmosphere, the UNFCCC adopts a factor of 21 to compare the warming impact to methane with CO₂.

Figure 2: (Left) Large, High-Efficiency Kilns at Plantar Optimize Temperature Control; (Right) Instruments Offer Remote Monitoring of Temperature and Combustion to Increase Efficiency



Source: Authors.

The research and development (R&D) conducted by the Plantar Group under the project indicated that temperature control is critical to optimize wood carbonization, that is, the charcoal-to-wood conversion rate (gravimetric yield), and thus increase kiln efficiency. Thus, improvements in energy yield through temperature control and other measures reduced methane emissions. A new seal system reduced emissions of particulate material and volatile gases, improving workers' health and safety conditions, and minimizing local impacts on air quality. Because the new process demands less biomass per ton of charcoal, it also allows for more efficient land use—smaller forest areas for a given level of pig iron production. The new process also provides stronger basis for the potential re-use of gases, including possibilities of energy co-generation, which is yet under analysis.

Plantar Group developed a methodology for CDM to measure reductions of methane emissions based on the weight ratio between dry charcoal and dry wood. The methodology (AM-0041¹³) was actually approved by CDM in November 2006, and a project design document was submitted and validated by a DOE. Validation confirmed that (1) previous traditional kiln design and operation was replaced by a newer design which aimed to mitigate methane emissions; (2) the project measured and monitored the yield by weight in the charcoal-making process and used these values according to the methodology; and (3) emission reductions would amount to 80,323 tons of CO₂e per year, compared with carbonization units using pre-project technology, and (4) such emission reductions were additional. Following validation, the carbonization component of the Plantar project was registered with CDM on August 9, 2007.

However, certain restrictions imposed by the CDM methodology approval process changed calculation parameters for the baseline after the project had begun 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 the Plantar Group concluded that it was not worth the cost of the verification process. Thus, no CERs were issued for the corresponding emission reductions. Ultimately, the PCF switched the CERs it would have received from this component to CERs generated in the other project components (pig iron and reforestation). Still, the fact that a technology was developed, validated, and implemented to reduce methane emissions is a significant outcome of the project. It also generated important social benefits for the health of kiln workers. Both the efficiency-enhancing technology and the weight-based measurement pioneered by the Plantar Group have been widely adopted in the charcoal industry in Brazil, generating a substantive spillover effect.

Carbon credits earned

The Plantar Group generated carbon credits or CERs from two of the three projects registered in CDM (as mentioned earlier): reforestation (carbon sink), and use of renewable charcoal in pig iron production. As stated in the last section, reduction of methane emissions did not result in the issuance of CERs.

Reforestation project: CERs for net absorption of CO₂ through new eucalyptus plantations amounted to about 4 million tons of CO₂ equivalent (tCO₂e), issued by CDM on April 13, 2012, for the 10-year reporting period, November 10, 2000 through November 9, 2010. The verified amount of emission reductions from 11,642 hectares of forest plantations was 67 percent higher than originally estimated, due to a longer growth period before harvesting and higher mean annual increments. Out of the 4 million CERs generated, PCF bought 1.5 million tCO₂e, and the BioCarbon Fund bought 1.3 million tCO₂e (which were actually “temporary CERs”).¹⁴

Renewable charcoal in pig iron production project: Under the CDM project on the use of renewable charcoal instead coke in pig iron production, emission reductions were estimated and certified as 75 percent of the baseline emissions for the entire production chain from plantations through carbonization and smelting. Between emission reductions in the industrial process and the absorption of carbon in the

¹³ AM0041: Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production --- Version 1.0 (<https://cdm.unfccc.int/methodologies/DB/B2SCH5WZLQYHTVSHQ4BIADMCBQ1P9U>)

¹⁴ Temporary CER or 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).

plantations, the environmental gain toward mitigation of climate change was about 3 tCO₂e for each ton of iron produced.

To date, the Plantar Group has generated certified emission reductions for three periods:

- December 28, 2012 - December 31, 2014: 465,967 tCO₂e
- January 1, 2015 - December 31, 2015: 210,826 tCO₂e
- January 1, 2016 - December 31, 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 drop in production of pig iron relative to expectations at project design, mostly as a result of the international and domestic economic crises and subsequent reduction of international demand. Plantar Group 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 Group applied rigorous environmental and social standards to the integrated production process. Following Brazilian environmental legislation, all parts of the project were submitted to comprehensive environmental impact studies and World Bank safeguards.

Environmental safeguards. The projects obtained all necessary environmental licenses, as reviewed and issued by the state environmental agency. In addition, all the forest areas in 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 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-megawatt power plant, has a comprehensive pollution control system, adequate pollution abatement equipment, 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 the safeguards requirements.

Social responsibility. The Plantar Group 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 plantations. The Plantar Group promotes social, cultural, and economic development projects to generate income in local communities (e.g., honey production within the plantation areas, employee-neighbor trade fairs where neighbors can sell their products to the project's employees). Plantar undertakes frequent consultations with local stakeholders and maintains open 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 *Jornalpto*, 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 which 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 to comply with national law. The project did not use or replace any native vegetation in its production chain. Thus, there is 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; and
- Linked project delivery to policy influence, through contribution to Brazil's national climate change agenda.

Effective Partnerships and Stakeholder Engagement

The partnership between Plantar Group 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 DOEs 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 Group 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 NGOs¹⁵ 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 Group. 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 adopted Plantar's proposal for the three new methodologies for baseline definitions and for monitoring emissions and emission reductions.

The World Bank also supported Plantar Group 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 Plantar 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 Plantar Group.

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 taken 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

¹⁵ 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.

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 Plantar 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 ERPA 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 Group 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 Plantar Group.

Plantar Group 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, were the benefits to Plantar’s workers in terms of occupational safety and health.¹⁶

The technology of **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) **loan financing for plantations and for pig iron production** was quite difficult at the time. Plantar Group 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 upfront 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

¹⁶ 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.

securitization of receivables. When PCF made the payment for the CERs purchased from the Plantar project, the payment was transferred directly to Rabobank which served as the loan re-payment for Plantar Group. This arrangement helped reduced the potential risks from foreign exchange rates. Additional revenue from the sale of CERs has helped the Plantar Group 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 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 Group states that it would not have undertaken the project without this component.

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 Group became an active participant in the domestic debate on climate change policy at the national, state and sector level. Plantar has often been consulted and invited to take part in the design of several policy initiatives and positions at the domestic and international levels, including a solid engagement within UNFCCC meetings. Several contributions have been made, as the country established mitigation policies and programs, , 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 **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” – 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.¹⁷

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),¹⁸ Brazil committed to a 37% reduction of GHG emissions by 2025 from a 2005 baseline scenario. Discussions began in Brazil about how to implement its INDC, including in strategic

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http://www.mma.gov.br/estruturas/smcq_climaticas/arquivos/plano_setorial_siderurgia_sumrio_executivo_04_11_10_14_1.pdf

¹⁸ The INDC informed by Brazil to UNFCCC do not mention the iron and steel sector specifically but include “restoring and reforestation 12 million hectares of forests by 2030, for multiple purposes”.

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 (GEF) and implemented by the United Nations Development Programme (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.¹⁹ The project concept originated by the Plantar Group 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. The company 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.²⁰

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 to work on its rules, procedures and methodologies. The entire process of CDM project formulation and processes (e.g., validation, 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 Group, 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. The Plantar Group and the World Bank

¹⁹ Project title: Production of Sustainable, Renewable Biomass-based Charcoal for the Iron and steel Industry in Brazil

²⁰ <https://www.cdp.net/en>

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, the Plantar Group 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 increase financial returns while also increasing the efficient use of natural resources, and reduced GHG emissions.²¹

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 some international NGOs, as well as 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 Group, 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 and influencing 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.

The project was implemented at a time when returns in the form of carbon credits could be expected, but were not 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, 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 Group would not have planted as much eucalyptus as it did, would not 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. Overall, the demonstration effect which directly 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 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 borne by Plantar Group 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 by 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

²¹ The eventual failure of getting credit for reduced methane emissions notwithstanding

have been created to allow Plantar Group to incubate their 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 not guaranteed from the outset. In the situation when the project was first identified and formulated, when Plantar Group entered into the ERPA agreement with the PCF, the World Bank placed full confidence in Plantar Group as a reliable, highly committed partner; Plantar Group similarly trusted the World Bank's long-term commitment to the initiative. The project would not have been successful without this mutual trust.

Future Outlook

The future of the Plantar project and of its ability for replication is uncertain. The last ERPA with the BioCarbon Fund expires in December 2018, when Plantar Group delivers its 1.2 million tCO₂e of CERs from the industrial project. Considering that the project has the potential of continuing for two more crediting periods under the CDM or a potential new mechanism, Plantar Group 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 BioCarbon Fund 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. As a result, Brazil's pig iron industry is currently experiencing a situation similar to the one observed at the beginning of the project: although planted forest stocks have increased in absolute terms and more than 80 percent 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 percent 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 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 benefit from 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 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 supply-demand unbalances in the market, including demand side restrictions on the use of CDM credits and an oversupply of emission allowances by the European Emission Trading Scheme, which also affected the CER market.
- Linked to the emissions market point above, there are so far, no national policies in Brazil that would internalize the cost of GHG emissions, either through a carbon tax or a 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”).

- Regulations on the future of the new market mechanisms under the Paris Agreement (Article 6), the transition from the CDM, as well as on the use of credits in relation to NDCs are yet unclear.. Nevertheless, considering the much more ambitious national targets pledged under the **Paris Agreement**, there could be a higher demand for certified units. The prospect of a fair transition into new market mechanisms under the Paris Agreement or 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.²²
- These initiatives and many others across the world signal that there might be a **renewed role for carbon** crediting in the future.

Plantar Group 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 native species.

Conclusion

Overall, the Plantar project 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 Group is not a large company, which demonstrates the power of carbon finance in the transformation of mid-size agents.

Methodological level. The development of CDM methodologies was challenging, but it also illustrates how instrumental the Plantar case was in the creation of a global regulatory framework, built upon multilateral consensus. The methodological legacy, including its worldwide applicability, is a result *per se*. Several projects since then have been submitted to the CDM utilizing these methodologies.²³ This

²² 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.

²³ 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,

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 Group by the World Bank as Trustee of the PCF and BioCarbon Fund;
- innovative securitization agreement with a financial partner (Rabobank);
- CDM methodological requirements integrated with production quality management processes;
- practices to integrate with stakeholders at the global and local levels; and
- FSC certification in production practices (the only company certified in the pig iron integrated supply chain) *inter alia*.

Policy level. Understanding policy making at the national and multilateral (UNFCCC) levels played a crucial role in project implementation, since these considerations framed the broader regulatory framework within which direct project components operated. The project was 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 CER prices, especially attributable to the demand side, the project’s replication potential could have played a substantive role. There are still important lessons and foundations upon which future initiatives can build.