Carajás S11D Iron Project
A new impetus to Brazil’s sustainable development
This Vale publication aims to present the Carajás S11D Iron project to society.

The project represents an expansion of iron ore extraction and processing at Carajás Mining Complex, which has been operating since 1985. Since that year, as well as producing the best iron ore in the world, supplying the national and international markets, Vale’s operations in the municipalities of Parauapebas and Canaã dos Carajás in southeast Pará have provided Brazil’s North region with a strong cycle of economic and social development, while producing equally important benefits for environmental conservation.

In this publication, Vale intends to share with society its experience in Carajás and its forecasts about the expansion of the mining complex, making clear the S11D project’s importance for the existence of another cycle of sustainable development in the states of Pará and Maranhão – where Ponta da Madeira Port Terminal is located – and for the continuation of Brazil’s role as a major player in the global iron ore market.

The quantitative data about the S11D project provided here are estimates and should be considered as such.

August 2013
Who we are

Vale is a global mining company that is committed to sustainable practices throughout its business chain. Present in more than 30 countries, we are the world’s leading producer of iron ore and the second largest nickel producer, and we also produce copper, manganese, ferroalloys, coal, fertilizers and platinum group metals.

We invest in world-class assets, capable of creating value over the course of economic cycles, with long lifespans, low costs, scope for expansion and high-quality output. The company’s investment also extends to people and the environment. We seek to build a fair and inclusive organizational culture that values diversity, offers professional growth opportunities and prioritizes employees’ health and safety.

In addition, Vale is dedicated to building strong and open relations in the communities where it is present, and it is continuously looking for new ways of balancing human progress with nature protection.
Carajás S11D Iron project
A new cycle of development

The economic, social and environmental benefits already seen in Carajás since 1985 attest to the transformational potential of Vale’s new project

A project of extraordinary dimensions, Carajás S11D Iron will be the largest private investment in Brazil of this decade. It promises to provide new impetus to economic and social development in the states of Pará and Maranhão, while contributing to environmental conservation in the Amazon biome. As of 2016, once an operating licence has been obtained, the project will increase the quantity of iron ore extracted from Carajás Mining Complex in southeast Pará.

Vale arrived there in the early 1980s, when the idea of extracting riches from the soil in a forested area seemed very unusual. Over the course of the last three decades, the operation has proved a success, helping to improve the lives of the region’s people, strengthening the Brazilian economy and restricting the transformation of forested areas into pasture land.

Vale’s experience in Carajás has permitted the development of production and logistics technologies that will greatly reduce the environmental impacts of the future project, in terms of natural resources used and pollution emissions. When up and running, the S11D project’s mine and plant will consume 93% less water, use 77% less fuel and produce 50% less greenhouse gas emissions than a comparable operation using conventional methods. The new mining area will also be more efficient in its electricity consumption.

In the environmental field, great care is needed when operating amidst natural resources of incalculable value to Brazil and the world. Vale’s commitment to respect for the environment has motivated direct investments at company sites and on public land, now contributing to the protection of over 8,000 km², half in Carajás National Forest, which has given up just 3% of its area to make way for the mining complex.

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Carajás has also represented a step change for the economy of southeast Pará. Parauapebas, for example, has become the top exporting municipality in Brazil, enjoying growing tax revenues arising from economic activities generated from mining and increasing numbers of qualified employees. Similar results, albeit on a smaller scale, have been seen along the Carajás Railway and in São Luís, Maranhão, from where Carajás’ iron ore is exported. The S11D project promises a new cycle of development, generating 30,000 jobs in the states of Pará and Maranhão at the peak of the construction. This figure...
encompasses all workers needed to build the plant and expand the railway and Ponta da Madeira Port Terminal.

Strategic project for Vale and Brazil

In Carajás, Vale now simultaneously operates five open-pit iron ore mines. The complex is the biggest iron ore operation in the world, producing a product with high iron content (66.7%) and low levels of impurities.

S11D will supply 90 million metric tons of iron ore per year. When running at full capacity, the project will enable Vale’s total iron ore production in Pará to reach 230 million metric tons per year. Together with other planned projects in the region, S11D will make southeast Pará as important as the Iron Quadrangle region of Minas Gerais.

The project is named after its location (ore body S11, block D). The mineral potential of ore body S11 is 10 billion metric tons of iron ore, and block D alone has proven and probable reserves of 4.24 billion metric tons.

This is the biggest project in the iron ore industry, and it is key to maintaining Vale’s leadership of the global market in terms of volume, cost and quality. The project’s output will meet global demand boosted by growth in construction and the manufacture of machines, equipment, aircraft, cellphones and other essential everyday items made of iron ore.

The result of five years of environmental and engineering studies involving technical teams from Brazil, Canada and Australia, the S11D project builds on all the lessons Vale has learned from mining in Carajás. It also follows the company’s Sustainable Development Policy, which is aligned with global initiatives such as the United Nations Global Compact, the International Council on Mining and Metals (ICMM) and the Global Forum on Mining Industry Sustainability. One of the outcomes of these guidelines was the decision to build the S11D project’s processing plant and all its industrial facilities in areas of pasture land outside Carajás National Forest.

In all, US$19.67 billion will be invested in the project – US$8.09 billion to develop the new mine and build the processing plant, and the remainder spent on logistics infrastructure.

It is expected that S11D will begin operating in 2016, representing 3,600 long-term jobs in the region.

In the implementation phase alone, the project will generate approximately 3,100 direct jobs and 9,800 indirect ones in Pará.

The surface-mined ore will be transported to the plant along conveyor belts. It will then be processed using only the moisture it naturally contains, eliminating
the consumption of water in this stage. The product will then be taken to the Carajás Railway on a new 101-km branch line. In turn, the Carajás Railway, which is being double-tracked along a 504-km stretch, will transport the ore to Ponta da Madeira Port Terminal, whose capacity is also being expanded.

By June 2013, we reached 45% completion of the project’s physical work, involving investment of US$2.18 billion in constructing basic infrastructure such as access roads, the assembly of operational modules and facilities for employees, and the purchase of equipment and metal structures.

A construction licence for the project was granted in July 2013 and it is estimated that implementation will take three years. Attentive to local development potential and growing demand for qualified manpower, Vale is investing to train professionals in the region, thinking of their future employment not only on the project, but also in services and businesses generated by it.

In order to leave a positive legacy in the regions where it operates, especially in areas far from major urban centres, Vale invests in vocational training for the residents of the towns where it operates, offering free courses in partnership with nationally renowned institutions. The aim is to provide the socioeconomic development of the local community, facilitating access to job and income opportunities generated by S11D and businesses associated with the project, in areas such as hotels, food and general services.

In 2012, Vale’s Job Market Preparation Program trained 520 people in Canaã dos Carajás, up more than 265% from the 196 students who completed the course the previous year, giving a total of 716 course graduates. Conducted in partnership with the National Industrial Training Service (SENAI) and the National Commercial Training Service (SENAC), the program has so far provided five training cycles, focused on course content with the greatest potential for students to make use of in the S11D project’s construction work and in support activities in the region.

In a survey carried out with 304 students who completed the Job Market Preparation Program in 2012, it was found that 49% of them were already employed, less than one year after completing their course.

The year 2013 has also presented good results: in the first six months, 232 students completed courses on the functions of hotel housekeeper, industrial cook, industrial assembly worker and forklift truck operator. By the end of the year, it is expected that 255 places on new courses will be available.
### Job Market Preparation Program — 2011/2012 — Courses

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<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
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<td>2</td>
<td></td>
<td><strong>2</strong></td>
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<tr>
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<td><strong>2</strong></td>
</tr>
<tr>
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<tr>
<td>Welder (general / arc)</td>
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<td><strong>3</strong></td>
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<tr>
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<td><strong>1</strong></td>
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<tr>
<td>Management of small hotels</td>
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<td><strong>1</strong></td>
</tr>
<tr>
<td>Industrial cooking</td>
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<tr>
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### Job Market Preparation Program — 2011/2012 — Graduates

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<tr>
<td>Metal structure assembler</td>
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<tr>
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The Carajás S11D Iron project will inject US$19.67 billion of investment into the economy, representing 26.2% of total planned investment in Brazilian mining up to 2016, and 42.7% of the amount to be invested in the iron ore segment in the same period.

Regionally, the project will spark a new cycle of development, by contributing to an expansion in the production chain in the states of Pará and Maranhão, with multiplier effects for income, the job market, tax revenue and the business environment in general. Vale’s confidence in the initiative’s success is based on the lessons it has learned during more than 30 years of activity in the North region.

By implementing the S11D project, Vale will reinforce its position as a global leader in the mining market. The project will lead to improvements in regional railway and port infrastructure, with positive effects for logistics efficiency and the competitiveness of the country’s productive system. When it comes fully on line in 2016, the operation will produce 90 million metric tons of iron ore per year, only slightly under the current output of Carajás Mine, reached after two decades of operation.

S11D’s impact on foreign trade is a good measure of its importance to Brazil’s economy. In 2012, iron ore represented 80% of the country’s mineral exports, amounting to US$31 billion, no less than 12.78% of Brazil’s total exports. Vale was responsible for around 80% of these sales. The North region alone accounted for 29.7% of Brazil’s iron ore exports.

Vale's new project in Canaã dos Carajás will induce regional development in Pará and Maranhão, besides contributing to Brazil’s trade balance

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Of the US$19.67 billion total budgeted investment, the bulk (US$11.58 billion) will be in logistics (railway and port), with the rest allocated to the mine and plant. By June 2013, US$2.18 billion had already been invested in constructing basic infrastructure, such as access roads and facilities for employees.

In order for S11D to start up, besides investing in the mine and plant, Vale is also constructing associated infrastructure dedicated to transporting the operation’s output. This includes building a branch railway line in southeast Pará to connect the ore processing plant to the Carajás Railway, double-tracking the Carajás Railway, and expanding Ponta da Madeira Port Terminal in São Luís, Maranhão.

A new 43-km highway has already been delivered. Linking a rural part of the municipality with its main urban centre, Canaã dos Carajás Municipal Highway was officially opened in May 2013 with an “Integration Race,” open to the community and project workers. The event featured 5-km and 10-km races, in both women’s and men’s categories.

The sums invested by Vale in logistics and technology will guarantee more than just efficiency, growth and sustainability for its operations: they will enhance the country’s competitiveness as a whole.
The S11D project will incorporate the lessons learned in the more than 30 years that Vale has been contributing to the development of the North region, investing heavily to unleash its mining potential.

The municipality of Parauapebas, Pará, is home to Carajás Mineral Province, the biggest iron ore producer operating in the world. Carajás encompasses five open-pit mines run by Vale: N4E, N4W, N5E, N5W and N5S.

Pará is also the starting point of the longest passenger train line in Brazil, the Carajás Railway, which extends for 892 km, crossing 25 municipalities until arriving in São Luís, Maranhão. The passenger train carries around 1,100 people per trip between the two states. This railway also features the world’s biggest freight train, with 330 train cars, which as well as iron ore, also transports manganese, pig iron, copper and other types of cargo, such as soybeans and fuel.

Environmental protection
Unlike many people think, mining can contribute to environmental protection. This is what Vale’s presence in southeast Pará demonstrates. Since it began mining iron ore in the region in 1985, the company has helped to preserve 400,000 hectares of native jungle in Carajás National Forest and other areas of the Amazon biome, in partnership with the Chico Mendes Institute for Biodiversity Conservation (ICMBio). The company also operates a tree nursery capable of producing 1.2 million trees of 300 Amazon Rainforest species, with the aim of reforesting around 10,000 hectares of land around Carajás National Forest.

Experience gained in more than 30 years is brought together in S11D, a project carefully planned to achieve operational excellence

Year after year, Vale has also evolved in the development of technologies and management systems enabling it to reduce the impacts of its operations. All this experience gained in more than 30 years is brought together in S11D, a project carefully planned to achieve operational excellence.

Carajás National Forest, home to a number of iron, manganese and copper mines run by Vale, and which will also accommodate S11D, is a Conservation Unit created in 1998 by presidential decree. Its objectives include the “sustainable exploitation of natural resources,” such as mining. Vale’s operations occupy just 3% of the forest’s total area of approximately 4,120 km². In addition, Vale’s support has been fundamental to preventing cattle farming and logging from invading the forest. Aerial images show that, outside the boundaries of the Carajás Region Mosaic of Conservation Units, the region is dominated by pasture land and logged areas.

Four adjacent areas covering 4,559.5 km², together with Carajás National Forest, make up the Carajás Region Mosaic of Conservation Units. This mosaic is protected by a partnership between Vale and ICMBio.

Comparing the satellite images from 1985 and 2010 shows the importance of the protective work undertaken in the Carajás region to preserve the Amazon Rainforest.
which conducts inspection, research, fire prevention, firefighting and environmental education activities. Furthermore, the Vale Fund for Sustainable Development works in partnership with social and environmental organizations to contribute to the conservation of the Amazon. The Fund’s initiatives include a project to continuously monitor deforestation in 100% of the Brazilian Amazon and support for institutions that look after 63% of protected areas in the state of Pará.

Vale’s contribution to the conservation of the Amazon biome is just one example of what the company is doing globally, as it is present in many parts of the world, protecting significant expanses of native forest. The company protects or helps to protect an area 3.5 times larger than that occupied by its global operations, amounting to 13,700 km² of natural habitat. In 2012, Vale invested US$1.025 billion in environmental protection and conservation, in line with the amount it invested the previous year.

**Innovative solutions**

In the S11D project, concern to reduce environmental impacts starts with the site chosen for the iron ore processing plant – an already deforested area outside Carajás National Forest.

With this same purpose of minimizing the impacts on forested areas, 70% of the branch railway line that will take S11D’s output to the Carajás Railway will also be built on pasture land. Along the stretch that passes inside the boundaries of the Conservation Unit, a tunnel and bridge will be constructed to avoid direct impacts on flora and fauna, requiring additional investment of R$200 million.

Once operating, the S11D project will follow various procedures in order to minimize the negative environmental impacts.

In line with Vale’s strategic commitment to “reduce water demand in its operations using new or existing technologies,” the ore will be processed using the moisture it naturally contains, cutting water consumption by 93% in relation to the conventional process, which requires intensive use of the resource. This technique also eliminates waste generation and maximizes ore use, since the finest particles, which would be washed away using the traditional method, become blended into the final product. In addition, 86% of the water withdrawn in Vale’s facilities will be reused.

Vale is also committed to reducing its projected 2020 greenhouse gas emissions by 5%. Three measures will contribute to achieving this target. The one with the
biggest impact is the adoption of a truckless system to transport iron ore to the plant. Rather than using 100 off-highway trucks for this task, a structure composed of excavators and mobile crushers will extract the iron ore and feed 37 km of conveyor belts, which will take the product to the processing plant. This measure, besides reducing the quantity of wastes, such as used tires, filters and lubricants, will cut fuel consumption by 77%.

Compared with conventional methods, the truckless system and ore processing using natural moisture will together cut S11D’s annual greenhouse gas emissions by 50%, or 130,000 metric tons of CO₂ equivalent. In addition, the main equipment used at the project will be powered by electricity. Only crawler dozers, motor graders and other auxiliary equipment will run on diesel.

Carajás Region Mosaic of Conservation Areas – composition

<table>
<thead>
<tr>
<th>Unit</th>
<th>Area (km²)</th>
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<tbody>
<tr>
<td>Carajás National Forest</td>
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<tr>
<td>Tapirapé-Aquiri National Forest</td>
<td>1,900.0</td>
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<tr>
<td>Itacaiúnas National Forest</td>
<td>1,414.0</td>
</tr>
<tr>
<td>Tapirapé Biological Reserve</td>
<td>1,030.0</td>
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<tr>
<td>Igarapé do Gelado Environmental Protection Area</td>
<td>216.0</td>
</tr>
<tr>
<td>Total</td>
<td>8,679.5</td>
</tr>
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</table>

Due to its natural conditions, Carajás National Forest presents difficulties in firefighting and the detection of outbreaks of fire. Because of this, the S11D project is investing in a monitoring system capable of identifying outbreaks in up to five minutes, the average time, according to studies, in which smoke reaches the treetops.

Installed in partnership with the Chico Mendes Institute for Biodiversity Conservation (ICMBio), the Forest Fire Finder System precisely locates outbreaks of fire, instantly supplying geographical coordinates, images and atmospheric data, such as temperature, humidity, wind direction and speed, atmospheric pressure and rainfall. The system also indicates the best way of accessing a site where there is a fire, enabling firefighting teams to get to the scene in the initial combustion phase, reducing the impact.

Users of the system have access to information in real time, 24 hours a day, through a website specifically created for this purpose, which can be accessed from computers, cellphones or mobile devices installed inside vehicles. Fires are detected using a scanning unit equipped with an optical camera with long-range lenses, which can rotate 360° horizontally and 45° to 90° vertically.

The Forest Fire Finder System is part of the Forest Fire Prevention and Combat Program for Carajás Mining Province and the surrounding region, run by Vale in partnership with ICMBio. This program encompasses various initiatives, such as preventive campaigns involving communities near environmental protection areas, carried out during the dry season, from June to November.
Since Carajás Mining Complex began to be implemented in the 1980s, southeast Pará has experienced strong population and economic growth. Significant generation of income and jobs has attracted many workers from outside the region, putting pressure on public services and housing supply, among other effects.

Aware of these impacts, Vale has been contributing to improvements in infrastructure and developing closer relations with communities in order to identify the needs and potential of each region.

The impact of large mining projects on the socioeconomic development of the locations that host them can be seen in data presented in the FIRJAN Municipal Development Index (IFDM), an annual survey that tracks the evolution of all 5,565 Brazilian municipalities in three areas: employment and income; education; and health.

Between 2000 and 2010, Paraúnapebas, Ourilândia do Norte and Canaã dos Carajás saw rapid improvements in employment, income, education and health, outperforming the state’s overall performance in all of these fields.

In education in particular, Paraúnapebas saw very fast progress in its development rating in the last decade. This is confirmed in data from the national censuses of 2000 and 2010, conducted by the Brazilian Institute of Geography and Statistics (IBGE), which showed a halving of the illiteracy rate in the municipality in this period, from 16.3% to 8.1%.

Considering only the generation of wealth, one can see a significant difference between municipalities that host mining projects and ones that do not. The average salary when a mining development is at the operational phase is as much as five times as high as the previous average salary in the formal economy. According to the 2010 census, the highest-ranking municipalities in the state of Pará in terms of GDP per capita as of 2008 were Canaã dos Carajás (R$48,619.03) and Paraúnapebas (R$45,225.41).

Vale believes that the benefits of the S11D project will be even greater. Some of the professionals expected to work in the project’s implementation and operational phases have already benefited from continuous investment by Vale in local manpower training and development. The company provides training courses for professions such as assistant electrician, building painter, mechanical fitter, structural construction worker, construction assistant, carpenter and bricklayer.

To accommodate the employees who will work on implementing the project, three large accommodation facilities will be built to supplement existing hotel.
infrastructure in Canaã dos Carajás. One of them has been built at Vale’s Southeast Pará Support Site, 6 km from the town of Canaã, with the capacity for up to 3,500 employees. The two other facilities are being built near the site of the future processing plant, approximately 50 km from Canaã. These accommodation facilities will have administrative areas, laundry rooms, a kitchen, a canteen, training areas, a commercial centre, a leisure area and an ecumenical worship centre.

High-quality information guides social actions

Regional knowledge and identification of the impacts caused by projects such as S11D underpin Vale’s planning of social initiatives.

In 2012, the company structured an Issues and Stakeholders Model bringing together information about existing projects and operations, enabling more effective treatment of social issues related to different ventures located in the same region. This model makes use of information collected from dialogue with communities, socioeconomic studies, claim management and social action plans conducted by the company.

Since 2012, Vale has been improving its engagement practices by implementing structured long-term social dialogue processes. The aim is to promote the sharing of information, mutual understanding and cooperation between parties, allowing the company to consider the expectations and interests of communities when taking decisions.

Vale also produces socioeconomic studies of the different regions where it operates, including southeast Pará. These studies cover topics such as demographics, education, health, infrastructure and public services, supplementing environmental studies required in environmental licensing processes for projects and permitting a wider view of the regional context.

Based on knowledge of local circumstances, teams use a Claim Management Tool, launched in 2012, to address community claims, and they produce Multi-Year Plans for Social Action. Lasting five years, these plans are the main instrument used to manage Vale’s social spending, which in 2012 amounted to US$317.2 million.

The Vale Volunteers Program complements the company’s social work, running education, sport and leisure projects, providing aid to the victims of natural disasters, conducting environmental awareness-raising campaigns and holding recycling workshops, among other activities.

The program has five committees in Para, which coordinated 22 projects in 2012. In Paraíso, volunteers planted 1,000 native trees in Vila Palmares Sul, located within the Carajás Railway’s area of influence. In the same municipality, the Chess at Schools project helped public school children to improve their performance in logical subjects such as mathematics, which they were struggling with. In Marabá, Vale employees collected half a ton of food, which was delivered by the local Vale Volunteers committee to the town’s temporary shelter.

Other priorities of Vale’s in the towns within its areas of influence are to strengthen the system for guaranteeing the rights of children and teenagers and to combat the sexual exploitation of children – a complex social phenomenon that needs to be tackled jointly by all sectors: government, companies and the community.

In the municipalities of Ourilândia do Norte, Marabá, Paraíso and Canaã dos Carajás, local representatives have participated in mapping social protection networks for guaranteeing the rights of children and teenagers.

In the S11D project’s Social Space, speeches have been given to the residents of Canaã dos Carajás, truck driver service providers, Vale employees and contractors building the project, to help spread information about preventing AIDS, other sexually transmitted diseases and the sexual exploitation of children and teenagers.

Another initiative focusing on this topic is the New Alliances program, which aims to strengthen public management by structuring councils related to the system for guaranteeing the rights of children and teenagers, and by contributing to the management of childhood policies and connections between networks and organizations. In 2012, this program contributed to the training of 294 childhood and adolescence council members and guardianship councillors, indirectly benefiting 342,790 children and teenagers in Pará and Maranhão.
Valuing indigenous culture

Vale maintains extensive, permanent and structured dialogue with the indigenous peoples and traditional communities that live near its operations and projects. In this way, it seeks to establish a continuous engagement process to improve its management of the social, cultural, economic and environmental impacts of its activities.

The company enters into agreements and adopts an integrated vision of these communities’ long-term development, seeking to resolve conflicts and maintain positive coexistence. In Brazil, the company has agreements with 14 peoples living in five Indigenous Lands in the states of Pará, Maranhão and Minas Gerais.

Vale supports institutional strengthening and management capacity building for the indigenous peoples and traditional communities it has partnerships with. It also provides training for employees and contractors who work on projects, in order to share best practices for coexistence with indigenous communities.

In Pará, one of the initiatives conducted by Vale in 2012 was a cultural exchange between representatives of the Salobo project and the Xikrin do Cateté people, during the chestnut harvest period, in Tapirapé-Aquiri National Forest, near the project. In response to requests from the indigenous people, Vale also provided camp support infrastructure, emergency medical care, telephones and access improvements to reach the chestnut trees.

In 2012, actions of this kind in Brazil benefited more than 12,000 indigenous people of various ethnic groups.

Culture, leisure, convenience and citizenship are also part of S11D. The project will have Social Spaces created to promote integration among employees of service providers, encourage healthy habits and facilitate the everyday lives of workers by providing products and services.

Opened in 2012, the first Social Space has two multi-sport courts, a sand court and two turf pitches that can be used to play soccer, volleyball, handball and other sports, and to host championships organized by the project administrators.

For those who prefer to read, there is a library. Open every day, including on weekends and public holidays, it has a reading room, a loan service and a collection of 1,500 books — many of them donated by the employees themselves.

Besides sports and cultural facilities, the Social Spaces will also have stores offering many kinds of services and products to employees and contractors, including internet cafes, clothes stores, convenience stores, beauty salons and snack bars.

These retailers have received technical support and participated in business gatherings involving the Commercial, Industrial and Agricultural Association of Canaã dos Carajás (ACIACCA), giving them the opportunity to see the project close up and exchange knowledge.

The Social Spaces will also function as disseminators of information related to health and citizenship, involving employees and community representatives in initiatives such as talks about preventing AIDS and other sexually transmitted diseases.
Innovation and technology
The pursuit of operational excellence

The S11D project brings together the main technological and procedural innovations developed by Vale in recent years

Vale’s experience of more than three decades in Carajás, together with the use of cutting-edge technologies and efficient production systems, make the S11D project the closest thing that exists to operational excellence in iron ore mining and processing. Its innovations simultaneously guarantee lower impacts on the environment and surrounding communities, and market competitiveness.

Like the other mines of Carajás Mining Complex, S11D is open pit. This system was defined in line with the geometry and positioning of the ore body, making it possible to use a mining method with lower costs and better work conditions, reducing potential risks to workers.

Open-pit mining at S11D will take place using a system based on truckless in-pit crushing and conveying technology, which was set during a three-year planning work, from 2006 to 2009, and is being constantly improved in studies and detailing projects. If the project had used conventional mining methods, 100 off-highway trucks would be needed for its mining operations.

Once extracted from the ground, the iron ore will be collected by excavators and deposited in mobile crushers. The crushed ore will then be fed onto conveyor belts, which will take it to the processing plant. In all, there will be 37 km of belts distributed around the mining area, including branches that will connect to the main 9.5-km trunk line to the plant.

By avoiding the use of trucks, the system will achieve significant reductions in diesel oil consumption, particulate emissions and the generation of waste such as tires, filters and lubricants. In addition, using conveyor belts will enable the plant to be built on pasture land outside the forest.

In turn, S11D ore processing will incorporate an innovative methodology developed by Vale, which uses the material’s natural moisture to aid screening. This technology, already employed successfully on a smaller scale in the Serra Norte (“Northern Hills”) area of Carajás Mining Complex, will cut water consumption by 93% in comparison with the conventional process. This saving is equivalent to the water used by a city of more than 400,000 inhabitants (19.7 million m³). Adopting this technology will also reduce electricity consumption by 18,000 MW per year. Another distinctive feature is the lack of a tailings pond, further reducing the need to disrupt native habitat.

If compared with conventional systems, truckless transportation and ore processing using natural moisture will cut greenhouse gas emissions by 50%, or 118,000 metric tons of CO₂ equivalent per year.

All of the greenhouse gas emissions incorporated in the scope of Vale’s emissions inventory were converted into metric tons of CO₂ equivalent in accordance with their specific global warming potential. The calculations were made in line with the GHG Protocol methodology.

Advanced automation and control system

The efficiency of the implementation phase will also be present after the operation starts up. This is because S11D will be integrated into the rest of Carajás Mining Complex, permitting a greater flow of operational information between its units.
The project also incorporates cutting-edge automation and control practices, with significant benefits in the use of its assets. These practices include more efficient management of energy resources, through the use of intelligent devices to adjust the supply of raw materials in line with process demands. The automation network will control all variables involved, deactivating equipment and consumption points that are not needed in situations with low demand or input levels. It will also use frequency inverters rather than conventional couplings, further improving energy efficiency.

**Enhanced safety for workers**

S11D will have the first ever ore processing plant completely built in modules. Crushers, screens and other equipment will be assembled around a large metal framework to form the industrial plant, like a giant jigsaw. This technology is relatively common in the oil and gas sector, but not in mining. To use it, Vale incorporated knowledge acquired in previous projects, such as Brucutu and Conceição in Minas Gerais, considering technical, environmental and safety aspects.

Modularization is a safer option for workers, as it permits a better distribution of personnel over time and greater control of the assembly site. In addition, the modules will be constructed off-site and tested before being transported to the definitive location, where they will be connected and operated. The system will also cut the implementation time, given that module assembly will take place simultaneously with earthmoving services and the construction of access roads.

In all, 109 modules will make up the project, including crushing and screening structures, coordination, storage and loading yards, and administrative facilities. It is expected that the assembly process will be completed by October 2014.

Environmental and economic benefits from screening using natural moisture

In conventional wet plants, all the water used in the process must be piped into tailing ponds, as it contains solid particles. This type of plant requires the intensive use of equipment (hydrocyclones, thickeners and filters) and pumping stations, using a lot of power, and does not permit usage of part of the processed material.

At S11D, the ore will be screened using its natural moisture, thereby dispensing with the need to use this equipment and tailings ponds, and enabling 100% of the material to be used. As a result, all of S11D’s mineral reserves will be fully exploited, without producing any waste or creating areas impacted by tailings dams.
The assembly of the first modules took place using material imported from China, one of Vale’s main customers. At the start of the process, two specialists from the country went to Canaã dos Carajás to monitor the work, which uses 100% Brazilian manpower. Overall, 35% of the equipment and structures bought by S11D are imported, while the other 65% come from Minas Gerais and São Paulo.

S11D’s complete structure will contain 67,000 metric tons of steel. Each module alone weighs from 25 to 1,200 metric tons and requires a specific engineering study in order to transport it. The heaviest modules will make up the crushing unit.

The modules are built on their side and then hoisted up and turned upright, when electromechanical assembly takes place. The components making up the modules are identified by colour: grey for structural items; orange for moving parts; yellow for safety and fall-protection components; and lilac for reinforcement materials, to be removed after transportation.

The first module that was completed, in December 2012, was 212M010, which will be part of the processing plant. It will contain silos, chutes, processing equipment and complete electrical and hydraulic components.

The modules are being transported using a self-propelled modular trailer (SPMT). This equipment has hydraulic suspension to guarantee lateral and longitudinal levelling on irregular terrain, thereby better distributing the weight of cargo on its axes and so reducing the impact on the roads it passes over. Operations are controlled remotely, using a joystick.

To transport S11D’s first module, in June 2013, a major operation was organized, involving various areas of Vale, municipal entities and the community. The 570.2-metric-ton module travelled along the 43-km Canaã dos Carajás Municipal Highway in an operation directly involving 31 professionals, lasting around 65 hours, spread out over the course of four days.

Six interesting facts about the modular system