3. Sustainable charcoal production in Brazil

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INTRODUCTION

Charcoal has been used as a source of thermal energy since the beginning of the steel industry in Brazil. Charcoal is used in the production of metallic iron from ore. Due to non-existence of sulphur in its composition, charcoal improves the quality of pig iron and steel produced. This phenomenon allows the steel industry to command attractive prices, Today, Brazil produces about 10 million tons of pig iron using charcoal, 60% are exported, generating an income of US$ 2.0 billion per year.

Pig iron is produced in two regions in Brazil. The first one is at Minas Gerais metallurgical region, located near the centre of Southeast Brazil. Back in the 15th century, iron mines and charcoal were already produced in these areas mainly from planted eucalyptus forests or imported from neighbouring states. Fuelwood used typically comes from native forests.

The other region is East Amazonia, along the railroad between the Carajás mineral district and the Itaqui harbour, in Pará State. The furnaces in Carajás have been in operation only recently, in the last two decades, to be exact. Since then, their production has grown significantly at an annual rate of 17.5% and currently reached 40% of total Brazilian pig iron production. The pig iron production in this area comes from charcoal that originates from from logs and residues. Take the case of one company, Companhia Vale do Rio Doce – CVRD. It produces 5% of total pig iron, and has planted forests to supply its charcoal demand. The demand for fuelwood to supply the charcoal consumed in Carajás is estimated to be at 12 million cubic meters per year. This translates to clearing around 200 thousand hectares of forests every year. Just for comparison, the 3,500 sawmills operating in Amazonia process 24 million cubic meters of wood annually.

There is now a growing concern about the future supply availability of charcoal. In order to understand these questions, this study will identify charcoal flows from different regions, describe briefly the process units involved with charcoal production, identify basic aspects in charcoal production and propose some criteria and indicators in order to improve the sustainability of this activity.

CHARCOAL SUPPLY AND DEMAND IN BRAZIL

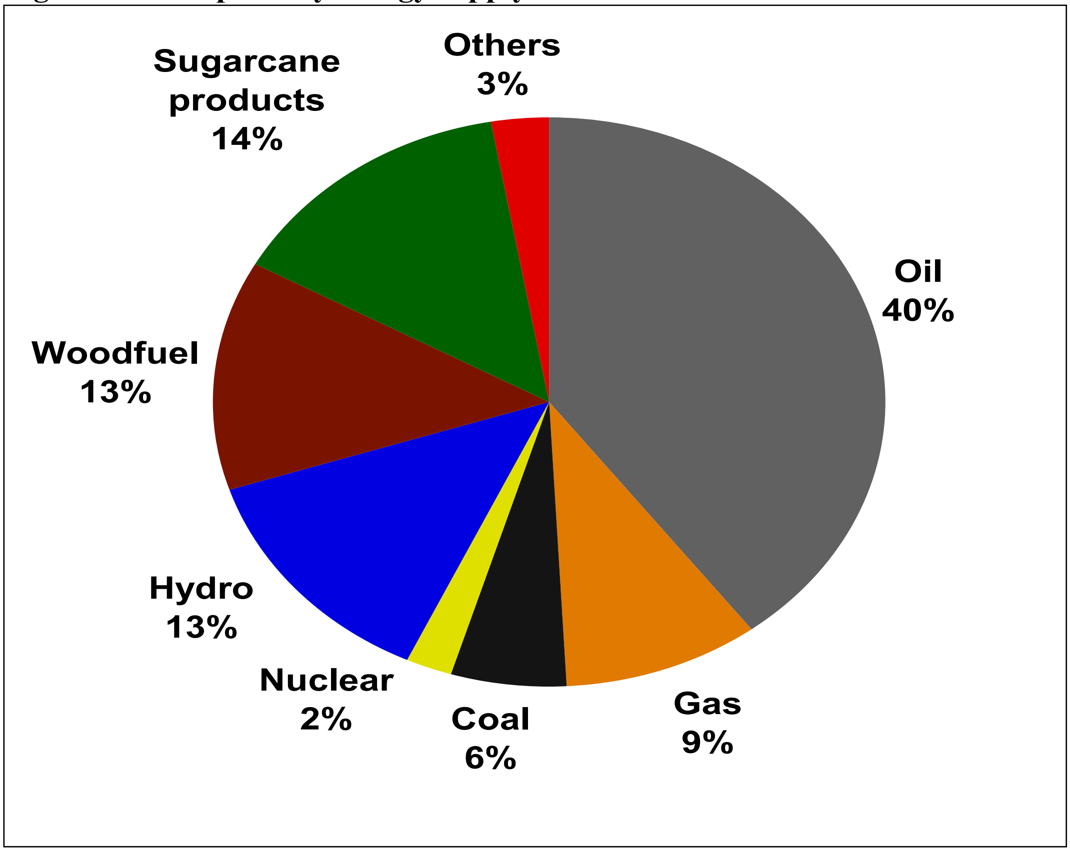
Energy use has been growing rapidly in Brazil. Total energy consumption nearly doubled between 1975 and 2000. Energy consumption per capita increased by 60% and energy consumption per unit of Gross Domestic Product (GDP) increased by 22% (GELLER *et al.,* 2004). Rapid industrialization, high growth in some energy-intensive industries i.e. aluminium and steel production, and the increasing residential and commercial energy services are among the main causes of increased energy use and energy intensity (TOLMASQUIM *et al.,* 1998). Total primary energy supply (TPES) grew in average around 2.5% per year in the last 20 years. This number is slightly higher than the annual economic growth rate of 2.1% during this period.

Energy policy in Brazil in the last three decades attempted to reduce the country's dependence on foreign energy supplies and stimulate the development of domestic energy sources, mainly from hydrocarbons. Also during this period natural gas and hydroelectricity production increased steadily over time; oil consumption decreased in the first half of the 1980s, but since the oil counter shock in 1986, it has been recovering its market share. The demand for coal increased due to the metallurgical sector while the residential sector decreased due to fuelwood substitution.

According to the Ministry of Mines and Energy, 13% or 28.4Mtoe (2005) of TPES is provided by woodfuels (Brasil, 2006). This is almost at the same level with the rate supplied by hydropower generation. Despite the importance of woodfuels in the energy mix, the demand for woodfuels steadily decreased from 1970 to 2000. In 2004 however, the trend reversed as woodfuel demand rose to the level similar to that during the 1980's (see Figure 2).

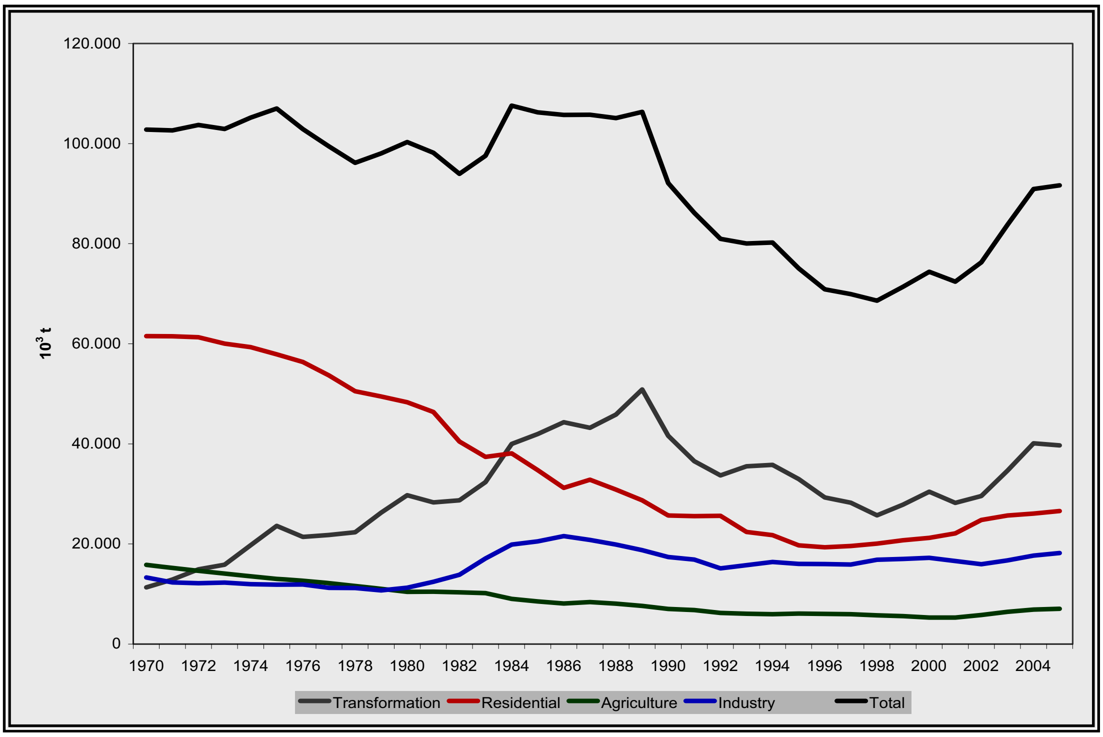
A strong driver in the decreasing consumption of woodfuels was the increment on the conversion into charcoal, as presented in Figure 2, this was directly related to the increase in the pig iron production in Brazil, Figure 3. Around 43% or 91.7 Mt of fuelwood consumed was converted in charcoal in 2005 (BRASIL, 2006). This charcoal was almost totally used in industry and residential sectors, as shown in Figure 4. These data were obtained from National Energy Balance issued by Ministry of Energy and Mines. It is important to note that some inconsistencies were observed.

Figure 1. Total primary energy supply in Brazil in 2005



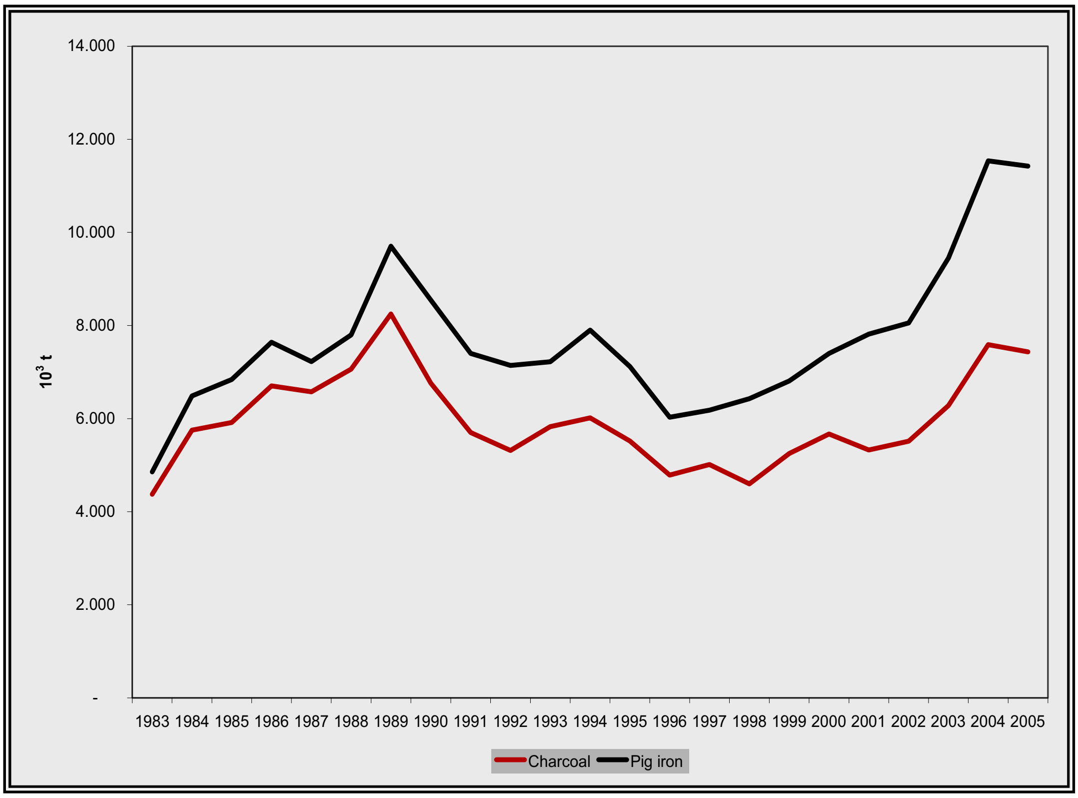
Source: BRASIL, 2006.

Figure 2. Woodfuel consumption in Brazil



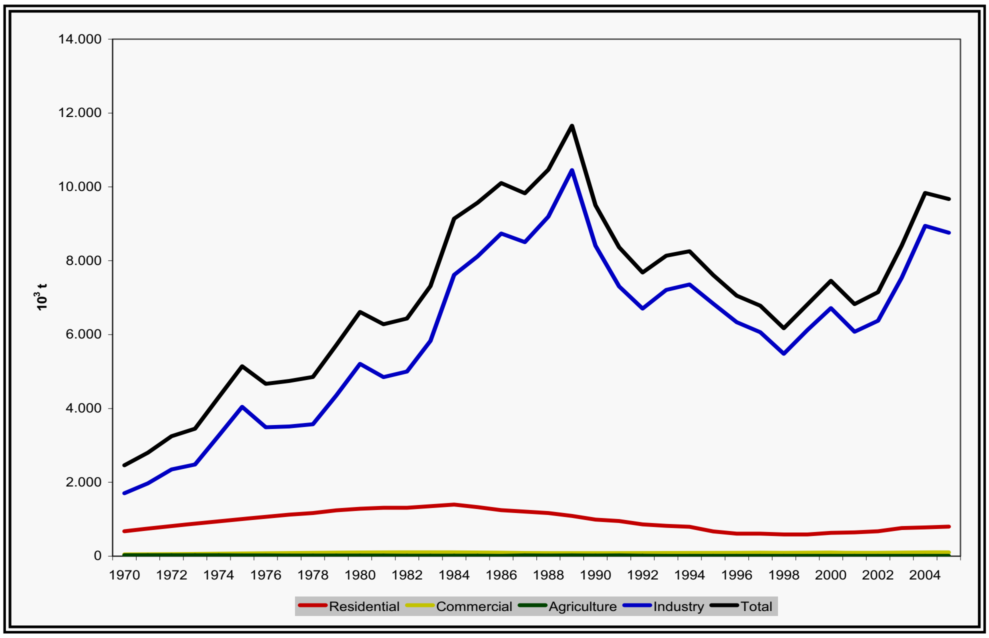
Source: BRASIL, 2006

Figure 3. Pig iron production and charcoal consumption



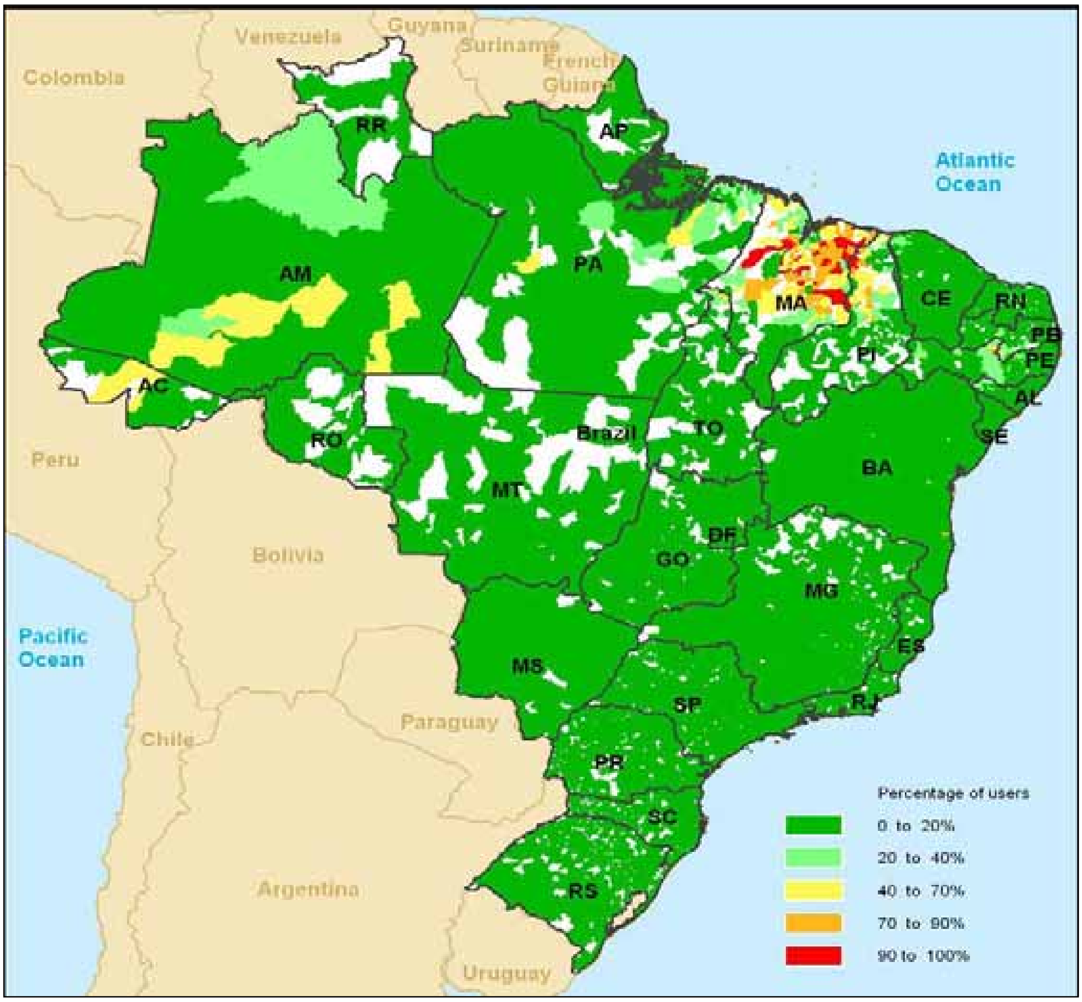
Sources: SINDIFER, 2007; BRASIL, 2005

Figure 4. Charcoal consumption in Brazil



Source: BRASIL, 2006.

Figure 5. Saturation of exclusive charcoal user at municipal district level in Brazil, 1991



Source: Prepared by UHLIG, A. from IBGE, 2004c.

In the last six years, charcoal demand has remained constant particularly in the residential sector. This represents 8.3% of total consumption. It is estimated that in this sector, 635.8 thousand houses or1.3% of national total, consume charcoal for cooking (circa 2003) at practically equal levels in urban and rural areas, as indicated in Table 1 (IBGE, 2004d). Percentage-wise this value may be small, but this translates however to the fact that in Brazil there are now approximately 2.4 million people relying on charcoal for food preparation. The charcoal consumption in residential sector can be traced in the Northeast municipalities, chiefly in Maranhão and Piaui States where by 20% of the houses use charcoal for cooking (Figure 5). It is believed that the source of charcoal for these houses comes from excess charcoal supplied to pig iron production at Carajás Region in Pará and Maranhão States (Figure 6).

Grilled and or barbequed food preparation is a matter of culture among Brazilians regardless of socioeconomic class. This is among the reasons why many households use multiple fuels e.g. charcoal and LPG to supplement or complement each other (Table 1). This is particularly true in the urban areas where charcoal bags (primarily to be used in grills) are sold in every supermarket and or gas stations in Brazil.

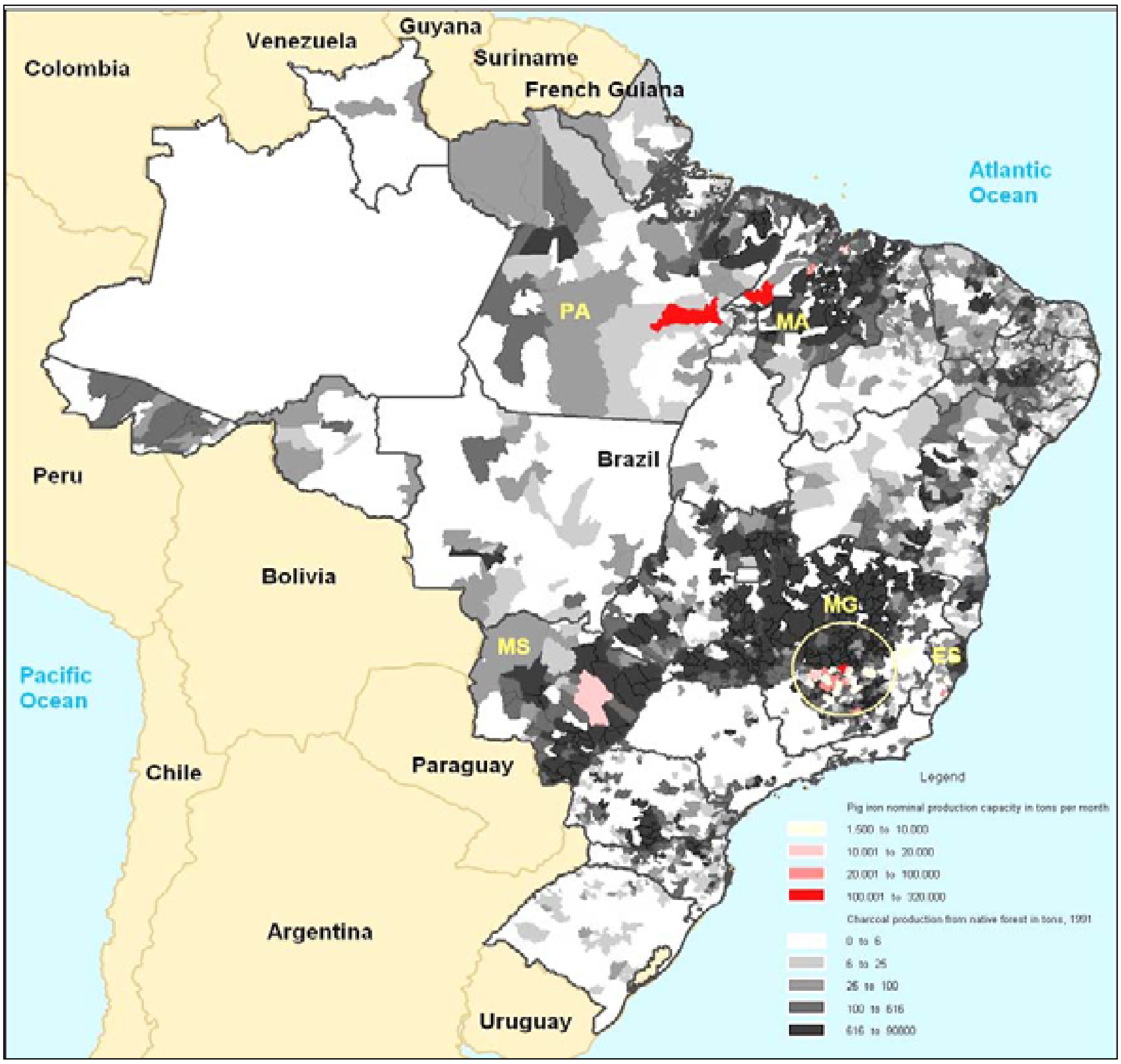
In the agricultural sector, charcoal consumption is not significant, representing only 0.1%. In the commercial and services sector, charcoal use is a bit larger and represents 1.1% and mainly used in restaurants (BRASIL, 2006). These information must be handled with care considering that it could be overestimated in some sectors e.g. residential and could also be underestimated in others e.g. industry and agriculture.

Table 1. Household consumption by fuel and situation in Brazil in 2003

Fuel	Urban	Rural	Total
Only LPG	31,916,473	2,480,533	34,397,006
LPG and fuelwood	3,007,274	4,096,489	7,103,763
Only fuelwood	462,382	1,312,046	1,774,428
LPG and charcoal	4,248,244	874,777	5,123,021
Fuelwood and charcoal	89,244	270,041	359,285
Only charcoal	323,916	311,889	635,805
LPG, fuelwood and charcoal	387,338	442,242	829,580
Total	**40,434,871**	**9,788,017**	**50,222,888**

Source: IBGE, 2004d

Figure 6. Charcoal production from native forest in 1991 and pig iron nominal production capacity at municipal district level in Brazil.



Sources: Prepared by UHLIG, A. from IBGE, 2004a and SINDIFER, 2007.

The industrial sector consumed 8.7 Mt of charcoal, representing 90.5%of total demand in Brazil. In 2005 the main consumers were pig iron production (84.9%), steel alloy production (10.1%) and cement fabrication (4.4%). As mentioned earlier, pig iron production is the principal user of charcoal in Brazil. Charcoal consumption pattern corresponds to pig iron production patterns.

Brazil has two important metallurgical poles for pig iron and steel production: the Carajás Pole (located in Maranhão and Pará States in North Region , and the other, the Minas Gerais State (located in the Southeast Region). Both poles produce 3.2 million and 5.8 million of pig iron respectively in 2005. This represented 92.3 percent of national pig iron production. In Maranhão State, there was an expansion of metallurgic companies after the beginning of iron ore exploitation at Serra dos Carajás. Charcoal was the preferred energy input to transform iron ore into pig iron.

Charcoal in Brazil is primarily originates from native forests exploration despite the moves to produce charcoal from planted forests. In 1990, 60.3% of Brazil's charcoal production came from native forests and in 2005, this percentage decreased to 53.0%, (Associação Mineira de Silvicultura – AMS). It is important to observe the spatial distribution of this production, as shown in Figures 6 and 7, respectively for native and planted forests. It is clear that the production of charcoal from planted forests occurs mainly in Southeast of Brazil.

The states that produce charcoal in Brazil are Minas Gerais, Mato Grosso do Sul, Maranhão, Bahia and Goiás. In 2004, their production statistics were as follows: 47.8%, 13.3%, 11.6%, 9.6% and 8.2%, respectively of national charcoal production (BACHA, 2006). The presence of pig iron companies in the area determines the concentration of charcoal production in the said regions. Typically , charcoal supplies come from within a radius of 200 km radius from these poles, marked with a yellow circle in Figures 6 and 7.

Figure 7. Charcoal production from forestry plantation in 1991 and pig iron nominal production capacity at municipal district level in Brazil.

Sources: Prepared by UHLIG, A. from IBGE, 2004b and SINDIFER, 2007.

In the 1990s, two tendencies on the charcoal used in the North were observed. The first tendency was that of a reduction of charcoal derived from deforestations and the growth of charcoal derived from sawmill residues. The second tendency was the increase in the distance from the biomass sources to the charcoal production in relation to the pig iron companies.

However, charcoal consumed in the Southeast of Pará and in the East of Maranhão still came from places close to the plants, as compared to the long distance covered by the charcoal consumed on the southeastern part of the country, where charcoal was transported beyond 800 kilometers. Apparently, charcoal production from forestry plantation was primarily near the biggest pole at Sete Lagoas, municipal district of Minas Gerais State. In reality, charcoal production did not take place near Carajás Pole.

Pig iron production diagnosis in Maranhão and Pará States

The pig iron industry on Pará and Maranhão States grew strongly on the last years basically due the proximity with the Carajás Iron Ore Mines, located in Pará State and the significant local availability of wood and wood residues for charcoal production. In 2005, in order to evaluate environmental conditions and impacts of such activity, officials from Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis -IBAMA made a huge operation on this region. Thirteen pig iron companies were visited to verify the process of charcoal supply and the legal conditions regarding charcoal production. A great part of the companies buy the charcoal from thirds or make supplying contracts with charcoal kilns operators installed on deforested areas that use fuelwood and residues.
To check the actual consumption of charcoal on these pig iron companies, IBAMA used the typical specific consumption parameters (in charcoal production, about 0.50 cubic meter of charcoal per stereo cubic meter of fuelwood and for iron ore reduction, by 2.9 cubic meter of charcoal per pig iron ton produced). With this approach, the consumption of charcoal could be estimated from pig iron production data, allowing concluding that 67% of the visited companies presented problems in charcoal demand information. It had estimated a difference of 7.8 millions cubic meters of charcoal between the real consumption and the declared by pig iron companies from 2000 to 2005. From the total volume of charcoal declared as used by the visited companies, totalled from 2000 to 2004, 14.2 millions of tons, only 7.5% comes from reforestation, while 55.7% comes from sawmill residues, 20.1% from deforestation, 12.2% from babassu and 4.5% from residue handling.

This mission demonstrated the strong pressure that the metallurgic pole on Pará and Maranhão States has done over the forest resources. The exploitation of authorized deforestation residues has been shown the easiest way for charcoal supplying in these pig iron companies that still have not become aware of the urgent necessity to obtaining such product on a more sustainable route. IBAMA indicates that according to the Forest Code it can apply fines of about US$ 18.2 millions, besides to oblige the reforestation of 60 thousand hectares (IBAMA, 2005).

SUSTAINABILITY ISSUES

Government agencies in Brazil have produced data pertaining to the production and consumption of charcoal for more than 30 years. Despite advances in estimation methods, the results still presented problems and deviations. Hence information found in this document should be dealt with caution. In 2006 the Ministry of Mines and Energy announced that a study was being developed to implement new methodologies to review the woodfuel data so as to improve its quality. To estimate charcoal consumption, primary surveys at national and regional levels were recommended. It was also pinpointed that the estimation methods should take into account consumption sites, fuel characteristics, and size of the industry.

A difficulty that remained was how to estimate charcoal supply and availability. Some proposals were studied that considered productivity of the forests by biome and using Geographic Information System (GIS), similar to that of WISDOM methodology as developed by FAO Forestry Department .

Sustainability and economics of charcoal in Brazil

Charcoal produced in Brazil is of industrial scale. The process involves carbonization of wood in poorly mechanized masonry kilns highly dependent on human labour. Despite the traditional procedures, according to IBGE (2006) commercial charcoal revenue earned in Brazil amounted to 5.5 millions tons in 2005 which generated US$ 785 millions in sales. These charcoal were obtained from both native forests (52.8%) and forestry plantation (47.2%) as shown in Figure 8 (AMS, 2007).

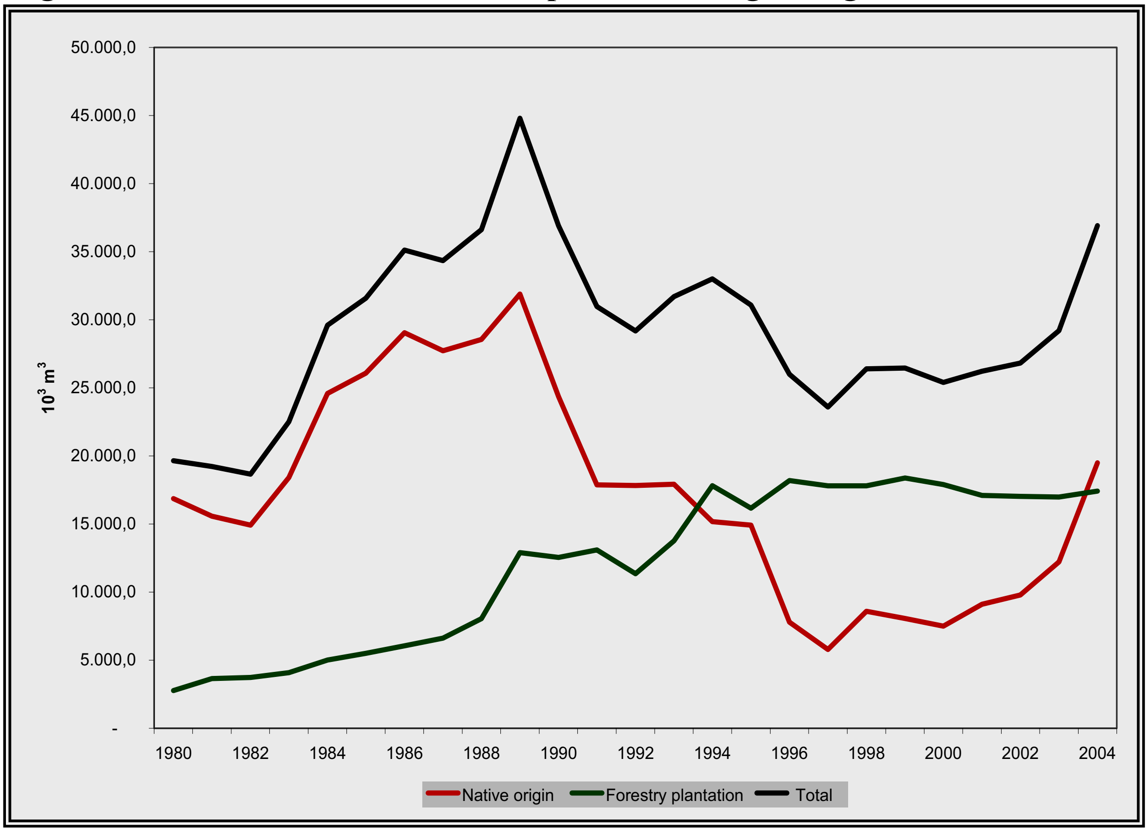
One observation is that charcoal produced from native forests decreased to 82% from 1989 to 1997, but it rose again after 1997, as a result of increased pig iron production in the North of Brazil. On the other hand, charcoal can also originate from: agricultural expansion, sawmill by-products, legal and sustainable logging, and illegal logging. As a whole however, it is estimated that charcoal production has recently caused deforestation at a dramatic rate of 200 thousand hectares per year.

The sustainability of charcoal-based pig iron production from native forests is becoming difficult. Native forest resources are becoming limited.As a result, the distance between charcoal sources and pig iron companies has increased. It is possible to observe charcoal being transported to as far as one thousand kilometers in order to reach consumer zone (BRITO, 1990), as shown in Figure 6. This situation induces pig iron companies to develop reforestation programs using rapid growing species to meet their charcoal demand (AMS, 2007).

Despite reforestation efforts, government surveys show that in Minas Gerais State, the main pig iron producer state, at least 11.5% of charcoal production from native forests comes from illegal sources and in the last three years, about 6,600 hectares were deforested to produce charcoal (MINAS GERAIS, 2007).

The exact figures of forest felled every year for charcoal production is not known. Hence the total extent of forest resources affected and the agents of deforestation are also not clear. However, these issues on management, accountability, inter-ministerial coordination and the sharing of forest revenues are becoming increasingly important and should be included in governmental agenda.

Figure 8. Evolution of charcoal consumption according to origin



Source: AMS, 2007.

Another relevant problem in promoting sustainable charcoal production is related to the prices for charcoal and other wood products. According to 2005 figures, reforestation for charcoal production was not encouraging because the price paid for charcoal was, in average, US$ 34 per cubic meter, while cellulose was evaluated by US$ 600 per ton in the same period. Thus, particularly during periods of low prices for pig iron, independent companies paid the lowest price for the charcoal, which can be produced profitably just using very low-priced feedstock.

Charcoal acquisition represents a large percentage in pig iron production costs averaging to as much as 40%. Therefore, charcoal is a main input for which pig iron producers tend to control to protect their profit margin. As the cost of the charcoal produced from planted forests reaches US$ 100 per ton, a value much higher than charcoal produced from native forest, it can make the pig iron production impractical (relative to international prices). Although in 2006 pig iron was commercialized at US$ 230 per ton, in 2002 exported pig iron was only US$ 103 per pig iron ton (Monteiro, 2005).

The dependence of pig iron makers on charcoal is so high that in 2004, when the international prices of pig iron rose to US$ 300 per ton, because of incrased demand from China, charcoal supply became a real concern for companies. When it happened, all the available wood was used to produce charcoal at Minas Gerais State and during those months the price of charcoal per cubic meter reached USD 65.00. By the time when there was no more available wood in Minas Gerais State, industries had to search for supplies in Mato Grosso, Pará States and even imported wood from Uruguay and Argentina just to produce charcoal (INEE, 2007).

Social and technology aspects

Many times, charcoal production is associated with inhuman work conditions such as slavery, unfair labour practice and child labor exploitation. Job contracts are typically temporary and workers do not have social welfare warranties (MONTEIRO, 2005). Although true in many cases, these conditions can be avoided and in several cases labor legislation is observed. In these situations, charcoal production takes place under legal conditions, demonstrating that negative working condition is not always an intrinsic or inevitable consequence of charcoal making.

There is no official estimate of the actual number of jobs provided by charcoal production. If a charcoal worker produces 50 tons per year, charcoal production provides employment to about 110 thousand people in Brazil in 2005. Wage rates of the workers directly involved on the charcoal production are between US$ 52 and US$ 113 per month. This means working hard for more than eight hours work per day. Commercial charcoal trade thus provides employment and income opportunities to thousands of people, particularly in depressed areas of Brazil like Vale do Jequitinhonha, one of poorest regions of Minas Gerais State.

The charcoal production technique in Brazil remains crude and primitive. The technology is still the same as one century ago. Operating the kiln is very simple and usually there is neither qualitative nor quantitative production control, Moreover, the current technology discards tons of valuable chemical components as gas emission, (although some companies manage to recover these gases). This is so since in the carbonization process, 30 to 40% of wood dry mass is transformed into charcoal the rest is released to the atmosphere. Gases from wood carbonization contain more than a hundred organic chemical components, including fuel gases, acetic acid, methanol and tar (BRITO, 1990).

Fuelwood carbonization takes place in a traditional way at masonry kilns with cycles of heating and cooling that last for many days. At present, the rectangular kilns equipped with systems of steam condensation and tar recuperators are the most advanced being used in the country. However, the kilns with small production capacity, without mechanization and without systems of tar recuperation, known as *rabo-quente*, shown in Figure 9, continue to be the most used charcoal kilns. They are constructed with ordinary bricks and have roughly a semi-spherical form. The temperature of carbonization is approximately 500ºC. The carbonization operation consists of filling the kilns through the doors with dry wood, closing the kiln completely, leaving a small hole on the top to make the ignition and a several other small holes on the floor level to allow air entrance. The completion of the carbonization process is indicated by the changing of the color of the smoke through the chimney. When this occurs, all the small holes are closed and the oven is left to cool for approximately three days.

A typical charcoal kiln is a battery composed by six kilns. This number is related to the carbonization cycle process, which lasts for a duration of six days. The procedure is such that one day is allotted to fill the kiln, another day and two nights for the carbonization process to take place, two days for the cooling and one day for the discharging. This way, each day, there is at least one kiln to be loaded with wood, another to be discharged with the semi-finished products and four ovens to allow the carbonization process.

The productivity of the charcoal production is affected by the operation conditions, kiln project and wood humidity. On average, it can produce 165 kg of charcoal per cubic meter of fuelwood, using primitive techniques and operating the ovens according to intuitive procedures. On the other hand, modern methods are able to increase yields to approximately 200 kg of charcoal per cubic meter of fuelwood (NOGUEIRA; LORA, 2003). There are only few known studies and researches being conducted to improve and to increase the efficiency of these equipment, which are going to be valuable sources of knowledge in order to achieve sustainability in charcoal production.

Figure 9. ***Rabo-quente*** **kilns for charcoal production**

Charcoal and climate change issues

Within the context of steel munafacturing, there are two raw materials used in the process that has carbon dioxide emission implications: Coal and charcoal. Coal is used to produce coke in steel production and charcoal is used for pig iron production in steel mills. As such, each ton of steel produced is equivalent to 16.4 tons of carbon dioxide sequestered when charcoal is used; and 16.4 tons of carbon dioxide is added to the atmosphere if coal is used in the production process (Campos, 2002). These are the reasons why proposals to qualify charcoal producing activities for carbon credits have been put forward (ECOSECURITIES, 2002).

Under the Clean Development Mechanism (CDM) incentives, charcoal-based pig iron production will allow a project entity to curb wood supply deficit and eventually become self-sufficient. As the project plantations mature, the project entity can become self-sufficient in the supply of charcoal. The Minas Gerais State experience in establishing plantations is a case in point. The Minas Gerais project activity is expected to result in twofold benefits: (a) generation of carbon stocks and GHG removals by sinks that would have occured in the absence of such plantations and (b) substitution of sustainable sources of biomass in place of fossil fuels and non-renewable biomass, which contribute to GHG emissions in the iron and steel industry.

The Afforestation/Reforestation – A/R Clean Development Mechanism - CDM project activity, exclusively focuses on the generation of net anthropogenic GHG removals by sinks through establishment of additional plantations. The charcoal produced from the plantations established in the A/R activity will be used in the pig iron production so as to limit GHG emissions by substituting renewable sources of biomass in place of fossil fuels and non-renewable biomass. Within the A/R activity, eucalyptus plantations will be established and land use is for at least a 21-year period, with the first harvest taking place after 6 to 7 years, followed by two successive periods of 5 to 7 years rotations through coppicing. This kind of project adopts a single 30-year crediting period and uses the temporary Certified Emission Reductions - tCER approach to account for the net anthropogenic GHG removals by sinks from the project.

CONCLUSION AND RECOMMENDATIONS

The charcoal crisis in Brazil presents an excellent opportunity for the country to review and pay serious attention to the use of wood as energy resource. It appears paradoxical how such relevant bioenergy is absent in the energy policy of Brazil. This is a matter of fundamental requirement for a country where 13% of its TPES comes from wood energy. Wood energy has become equally as important to hydropower which also accounts for the other 13% in TPES.

In Brazil, charcoal is a highly valuable resource and contributes much to its economy particularly in the pig-iron and steel manufacturing industry. At present however, there is dearth of information vis-à-vis charcoal-related policies/guidelines. As such, policies need to be formulated and guidelines have to be developed along these lines. There is a sense of urgency and importance particularly given the issues and problems of sustainability of the supply and production of charcoal. There are other environmental implications as well i.e. conservation and protection of forest resources, among others. A desirable forest policy that can be formulated is one that will promote the expansion of forest areas, apply the use of modern technologies, and cultivate improved forest management strategies in Brazil. It should be one that encourages the use of better charcoal technologies (i.e. recovery of by-products, reduction of emissions, etc.).

Aside from policy formulation, research and database management likewise needs to be formalized and developed for planning and documentation purposes. There is an immediate need to come up basic supply and demand balances, market studies, origins of charcoal production and identification of areas under stress, and studies pertaining to combustion efficiency, and many more.

In terms of regulation and enforcement, the forest recovery capacity for charcoal production has been studied for a long time. Forest recuperation was observed after 8 to 10 years of cutting without fire techniques in some Brazilian regions. This practice could be more pronounced in charcoal production areas where there is no speculation for agricultural expansion. On the other hand, Forest Zoning is another alternative. This can assure sustainable management, conserve important forested areas and thereby protecting the environment.

CDM Projects in charcoal production

The Plantar project consists of the maintenance of charcoal-based production of pig iron in its mills in Minas Gerais, Brazil, funded through the sale of carbon credits. This is the first investment of the World Bank PCF in Brazil, who retained EcoSecurities to determine the potential GHG emission reductions to be generated by the project. The project involves the planting of over 23 000 ha with sustainably managed (certified to the Forest Stewardship Council standards) forests of high yielding clonal *Eucalyptus* trees. Additionally, Plantar will initiate a pilot project of landscape-scale management of biodiversity based on the regeneration of native vegetation in an area previously covered with plantation forests. It was estimated that the project has the capacity to generate 12 million tonnes of CO2 emission reduction equivalents over a 28-year timeframe. The PCF is particularly interested on replicating this investment and its effect on the iron & steel sector as a whole. The project is currently being independently verified by DNV, prior to completion of the deal. EcoSecurities is also assisting other companies on similar initiatives. One of them is being developed by V&M Tubes do Brazil (a joint venture between the French group Vallourec and the German company Mannesmannrohren-Werke). V&M Tubes is the only steel pipe manufacturer in the world to use 100% renewable energy for the production of pig iron and steel. Its forestry division, V&M Florestal, is responsible for the production of all charcoal required by its mills, from its 120 000 hectares of plantation forests (certified as sustainably managed according to the standards of the Forest Stewardship Council). The project consists of investments to ensure the use of sustainably-produced charcoal for steel manufacture in Brazil, avoiding the use of coke from coal. It is estimated that this will result in the reduction of 45 million tonnes of CO2 emissions during the next 27 years.

To reduce the illegal deforestation in Brazil, actions have been done e.g. broader surveillance; launching projects that combat corruption and illegal logging, management of land ownership, and the creation of protected areas. This set of measures intends to reduce fraud, bribery and illegal logging. However, these will require enabled personnel and and proper legal basis for enforcement.

Although all the production chain of charcoal is formed by private initiative agents, it is important to launch initiatives and signals from the government on the regulatory, economic and fiscal fields, consolidated in a policy towards sound development of woodfuel and charcoal production and use, with some clear guidelines:

- Identify long-term production targets and timetables aimed at increasing supply and reducing costs of wood used for energy purposes such as charcoal;
- Create an organization, preferably at the regional level, that will be responsible for the establishment of a National Wood Energy Information System. This organization will be tasked to develop consistent methodologies, conduct of surveys, sourcing of funds and resources, information dissemination, and the preparation of annual wood balance report. It should also identify the “hot spots” where charcoal is unsustainable and deserves more attention.
- Define norms and standards on wood energy systems preferably similar to “Certification” techniques and methods. These standards and certifications should be aimed at promoting efficiency, reducing losses, increasing sustainability, and recovery of gas by-products in the charcoal making processes.
- Develop conditions for forestry-related scientific and technological development i.e. forestry and wood energy processes, and expertise in production, conversion and management of wood energy systems.
- Enforce regulations not only in transportation of charcoal but also in its final use.

Charcoal is a renewable source of energy and an important feedstock for steel production in Brazil. Energy-related and forestry-related policies need be seriously considered to assure long-term production and sustainability and improve social and environmental conditions. In the final analysis, let it be known that it is still possible to produce competitive charcoal with good efficiency and in the process, preserves natural resources and respects workers rights.

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