# A BRIEF HISTORY OF ENERGY BIOMASS IN BRAZIL

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## ABSTRACT

Energy biomass, in Brazil, can be considered one of the first fuels used in scale, facilitated by the natural resources availability in the country and by the possibility of rude technology use. This pioneer use has been established since the colonization period (century XVI) in the country, by the consume of deforested areas, using the wood as heat source to food cooking and to charcoal rudimentary production.

The raw material extraction (wood) was made in predatory way, without taking into account environmental aspects. It can be observed, nevertheless, that the existent exploration model during that time (subsistence economy) has not caused great damage in terms of forest areas loss, due the inexpressive volume of wood extraction.

The deforestation practice got importance when it was introduced the sugar cane in Brazil, brought from India by the Portuguese. The sugar cane cultivation was perfectly suitable to the country conditions: availability of fit big lands extensions, high insolation tax and favourable climate and soil factors.

## I-PRODUCTION AND UTILIZATION OF SUGAR CANE ENERGY BY-PRODUCTS

Since the colonial period until 1975, all the sugar cane production was transformed in sugar. In small scale, there was some alcohol transformation to industrial objectives (chemical, pharmaceutics, food, perfumes, etc...) and to the so famous Brazilian rum ("cachaça") fabrication.

In 1973, the petroleum international prices increased from US$ 2,84/barrel to US$ 12,27/barrel, causing important changing in world energy market. The dependent countries of imported petroleum were the ones which were more affected by the first petroleum international shock, mainly due the increasing of their external debts.

That was the Brazilian example. During the seventies, Brazil was strongly dependent of external energy (mainly petroleum), what have emphasized the effects caused by the first petroleum international shock in the national economy. Thus, the excessive importation of high price energy damaged the country's international exchange relations and contributed to the increasing of Brazilian external debts.

During the seventies, the Brazilian external energy dependence varied from 34% to 38%, considered a very high index in the circumstances of elevated petroleum international prices. This unsuitable panel resulted in the adoption of strategic measures aiming the diminishing of energy importation to reduce the dependence to around 20%. These measures represented an alternative to deal with the international situation in the next decades.

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After the first petroleum crisis, government decided to reorient the national energy policy courses, looking for the diminishing of the energy importation negative effects, mainly through: (Copersucar, 1989)

- research investments and petroleum extraction in national land;
- financial resources to the Brazilian hydroelectric system expansion ;
- creation of constraints mechanisms of petroleum's by-products consumption and investments in energy preservation;
- looking for alternative energy sources , being outstanding the Alcohol National Program (PROALCOOL-1975), with the introduction of alcohol as automobile fuel.

The PROALCOHOL implementation can be divided in two different phases:

a) "A first one initiated in 1975, destined to the using of the mills unused capacity, mainly with the implantation of distilleries annexed to the sugar mills. Related to the alcohol use, the first phase was known by the anydrous alcohol , mixed to gasoline in the proportion of 20% of alcohol and 80% of gasoline, without any adaptation system in the available vehicles..."

b) The program's second phase was simultaneous to the second petroleum international crisis in 1979, when the barrel's price increased from US$ 18,36 to US$ 30,72; besides, there were financial constraints circumstances in the international market.

The second phase presented important changing in the program objectives and in the alcohol production and consumption goals. The production increased mainly, in autonomous distilleries, with expansion in pioneer fields. The main kind of alcohol changed the hydrous one , to vehicles consumption, specially adapted for the exclusive use of the hydrous alcohol.

It is important to stand out that the existent structure has positively contributed to the program success, mainly because of:

-the existence of a very old and well developed sugar industry in the country, with a adaptable technology development to the alcohol production;

-existence of a large scale cane culture with an increasing trajectory, in despite of its low productivity indexes ;

-industrial sector adaptability to alcohol production directed to the chemical, pharmaceutics and drink industries;

-existence of several experiences in the field of alcohol technology such as automobile fuel which were being implemented to add alcohol to the gasoline or in binary mixtures (alcohol, ether) and ternary (alcohol, ether and gasoline) or even in using alcohol as pure fuel.

The immediate effect of PROALCOHOL – considered the best large scale production of liquid fuels from biomass – was the big increase of alcohol production in the country, making this experience to assume an extreme importance in world scenery.

The substantial production increase during the eighties was possible only because of the autonomous units entrance in the market, upgrading in annexed distilleries and better knowledge of energy conversion process by the mills.

With the autonomous distilleries in the market, all sugar cane was destined to alcohol production, establishing efficiency of around 70 litres / ton of pressed cane . The former situation, (all sugar cane production destined to sugar fabrication), developed in distilleries annexed to sugar mills presented an efficiency of 12 litres / ton cane.

In terms of cane production, the PROALCOHOL contributed to triple the production between the harvests of 1975 to 1976 and 1989 to 1990, presenting a productivity increase of around 30% during the same periods. At the present time, because of the developed

technologies , there was a considerable increase of agricultural productivity, mainly in São Paulo region , with an average efficiency of 100 ton/hectare.

Related to the dimension of the area used to sugar cane plantation, there was a great increase of cultivated soil (300 % from 1972 to 1986), although the total cultivated area for cane represents only 1,3% of total agricultural area in the country.

## II – PRODUCTION AND USE OF FOREST ENERGY BIOMASS

The wood was intensively used, mainly by the possibility of simple and inexpensive technology adoption and , also, by the great availability of native forests in the country, through predatory extracting techniques.

Until the seventies, the wood represented the first primary energy source of the country, oscillating around 40% of the national primary energy consumption used, mainly, in residential sector (food cookery), industrial sector (boiler), agricultural (grain drying) , transport (ship and locomotive furnaces burn ) and charcoal production (carbonization in rudimentary furnaces).

During the fifties, the country reached the consumption of 50% of primary energy as forest biomass. Nevertheless, the loss of existent forest was inevitable, seeing that beyond of the wood consumption by the non-energy sectors (laminated wood, furniture, paper and cellulose), there was a demand expansion for the product , by the new consumers emerging and the existent forests degradation caused by pasture and agricultural cultures practice.

As a consequence of the use of natural areas , the use of wood as energy has got, in course of time, a small tendency of fall, caused by the scarcity increase of native forests of the country. (Brito, 1990).

The energy crisis of the seventies caused a de-acceleration of this fall tendency , establishing the wood in the second position as primary energy consumption, being the petroleum in the first position. In the end of the seventies, in terms of primary energy consumption, the hydraulic energy excels the wood , which has occupied third position until nowadays.

After the petroleum crisis, the use of wood as energy source exceeded its use as non-energy (gross wood, laminated wood, cellulose paper).

The wood participation in primary energy matrix in the country has been maintained without important changing. From 1970 to 1994 there was a decrease of 23%, as it is showed in the National Energy Balance, 1995 (Table 1)

Nevertheless, analysing in details the use of wood as energy, it is found out the existence of discrepancies in its use in the transformation sector (charcoal production, power plants) and primary final use (residential, industrial, transportation, etc...).

**Table 1 – Evolution of the Forest Biomass (Wood) Energy Primary Consumption of) in Brazil Unit: 1000 TOE**

| USE/YEAR | TRANSFORMATION | FINAL USE | GROSS NATIONAL OFFER |
|---|---|---|---|
| 1970 | 3.463 | 2.799 | 31.453 |
| 1975 | 7.223 | 25.516 | 32.739 |
| 1980 | 9.106 | 21.589 | 30.695 |
| 1985 | 12.841 | 19.672 | 32.513 |
| 1990 | 13.024 | 15.441 | 28.465 |
| 1994 | 10.597 | 13.513 | 24.110 |

Source: BEN(1995)

Energy National Balance data show an expressive evolution of wood use for transformation centers in the period of 1970 – 1994 (206%), while the portion used as primary product has decreased 48% in the same period. The significant increase of wood use in transformation centers has contributed to the forest biomass primary energy total offer has not presented the same decrease observed in the wood final use as energy .

After the petroleum international prices increase and the progressive scarcity of native forest in Brazil, the energy wood production has been modified through a more intensive implementation of forest plantations, instead of the traditional use.

It can be pointed that this kind of wood production has showed important increase in the latest years, presenting production techniques exceeding , in quality, the extracting production way of wood exploration.

The silviculture to energy use in the country has began with the provision crisis created by the native forests scarcity near the consume centers. The initial production phase has been based in classic plantations**:** eucalyptus homogeneous reforestations, low forest density (1600 trees/hectare) and long cut cycles (8, 14, 20 years). The second phase has outstanding productivity with new species introduction **,** genetic improvements, seed production, new fertilization methods , soil prepare and forest management. With technological improvement it could be possible to implant more dense forests (5000 trees / hectare) and to diminish the cut cycle (3 to 5 years). (Borges, 1988).

Nowadays, the offering of energy forest biomass is destined , basically, to two finalities: transformation **(**charcoal, thermoelectric centers) with around 45% of consumption and primary final use (residential, transportation, etc...) with around of 55% of total consumption.

In transformation sector almost the total wood is destined to charcoal production for siderurgy

In Brazil, some issues have contributed to the use of transformed wood in charcoal destined to national siderurgy; some of them can be stand out:

- lack of national mineral deposit of metallurgic charcoal in good quality;
- many small siderurgies in the interior of the country;
- big potential of biomass use (technologic control and natural resources availability);
- use of less sophisticated production structure (in siderurgy by coke , plants, in general, imply in large production capacity in process using high temperatures);
- little dependency of products importation and of raw material international prices variations.

Nowadays, implanted forests establish a quite important part of wood production destined to charcoal production (around 40%) (ABRACAVE, 1994)

Meanwhile, the predatory exploration is still the most important way of obtaining wood to charcoal production. This can be explained by the following factors: (Acesita, 1991)

1) the wood demand to charcoal production exceeds too much the possible offering from energy forests;
2) the Brazilian rural population poverty (mainly in hedge), that use charcoal production as the most important income source;
3) use of rudimental technology to transform wood into charcoal , what facilitates the large access of low income population in the charcoal fabrication (the majority of charcoal furnaces have very inexpensive construction and operation since they are made of clay).

The charcoal demand from native forest in the country could be also explained by its use in the siderurgy (96% of charcoal production is destined to this sector), where around 60% of

the pig iron production come from independent small enterprises which have no financial and technological conditions to implement energy forests. To solve the supply problem , these small siderurgy firms buy the necessary raw material from the autonomous charcoal producers.

These producers get the wood to charcoal production in itinerant way. Thus, the charcoal furnaces follow the deforested areas, establishing a nomad activity, considered predatory, representing 60% of the charcoal production to siderurgy sector.

The use of native areas can be explained by cultural factors of rural populations and , even, by the extracting exploration model , which implies fuel production expenses near zero. In other words, "the raw material is available", not being necessary any sophisticated technologies of extracting, benefiting or transformation in useful energy.

The wood is cut, stored up and dried, being , later, burned in combustion chamber with thermodynamic efficiency around 15% in case of wood stoves (in residential sector). As a way of counterbalance the low efficiency of the adopted technology, the chose fuel must be full and with production costs almost none. In the contrary, resulting from the energy low efficiency, its use would be unfeasible .

The siderurgy, as main charcoal consumer, stimulates the wood extraction process demanding the charcoal proceeding from the small independent producers, although it can be noticed a tendency in the sector of a crescent participation of planted forests to supply the progressive demand by charcoal.

It is foreseen , for a near future, a charcoal production based in wood originated from planted energy forests. This expectation is based in the following issues: (Carpentieri, 1991)

-native forest scarcity;
-possibility of scale gains (economy in production)
-production integrated processes (energy efficiency gains)
-increase in charcoal transportation costs , due the distance of deforested areas.
-environmental legislation

The charcoal consumption of native forests presented crescent performance getting its maximum level in 1989, when the production reached 31,900,000 m3. From this moment on, there was a accentuated fall in the production, come upon of native forests, in around 17,826,000 m3(1992).

On the other hand, the production come upon reforested areas presented crescent indexes of participation.:

a) in 1980 the production was around 3,700,000m3 and reached to around 13,100,000 m3 in 1991, presenting a small fall in 1992.
b) in terms of percentage increase, based in 1980, the charcoal production originated in reforested areas had expressive performance, increasing around 350% from 1980, exceeding, with great advantage, the relative increase of charcoal production originated from native forests (90%).

The data of Brazilian Institute of Geography and Statistics (IBGE) allow the performance analysis of forest biomass production, detailing the energy and non-energy uses and, also, considering its origin, related to the several country regions, as renewable or non-renewable source. (IBGE, 1994)

From these data, it was elaborated Table 2 which permit the following considerations about the forest biomass use, during the period of 1974/1992:

-the wood for non-energy use and from native origin increased 104% and the planted forests production had an evolution of 191%.
-the primary energy consumption of wood from native origin presented a negative increase near 21% while the planted areas production had na evolution of 54%. In terms of absolute numbers, the native origin wood production is about 2,4 times bigger than the planted origin wood production. ( 1992).
-related to the wood for charcoal, the production from native origin increased 11%, while the one from reforested land has grown 168%.

**Table 2 – Production of Gross Wood, Wood and Charcoal in Brazil ( Origin: Native and Planted Forests) Unit:1.000 $m^3$ (wood) 1.000ton (charcoal)**

| Year<br>PRODUCT | | 1974 | 1978 | 1980 | 1982 | 1984 | 1986 | 1987 | 1992 |
|---|---|---|---|---|---|---|---|---|---|
| Gross WOOD | NATIVE | 25.959 | 32.289 | 36.212 | 36.982 | 39.924 | 44.670 | 45.744 | 53.067 |
| 1000(M3) | PLANTED | 17.992 | 33.311 | 41.827 | 42.366 | - | 40.680 | 47.935 | 52.428 |
| WOOD | NATIVE | 120.991 | 120.083 | 128.116 | 122.730 | 131.929 | 126.360 | 120.930 | 95.610 |
| 1000 (M3) | PLANTED | 18.405 | 34.412 | 30.961 | 28.564 | 26.680 | 44670 | 45.908 | 28.316 |
| CHARCOAL | NATIVE | 2.086 | 2.344 | 2.520 | 2.500 | 3.354 | 3.365 | 3.382 | 2.318 |
| 1000 (ton) | PLANTED | 714 | 369 | 670 | 1.158 | 1.610 | 2.010 | 5.619 | 1.920 |

Source: (IBGE,1994)

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