THE USE OF LOW GRADE COALS

Introduction

Mineral coal is the second largest primary energy source in the world, only outranked by oil.

Table 1 shows the largest coal reserves and Brazil's position in this respect.

Country	Reserves	%
USA	250392	24.2
China	114500	11.2
Australia	90940	8.8
India	69947	6.8
Germany	67300	6.5
Others	438531	42.5
Total	1031616	100.0
Brazil	2845	0.3

Table 1 –World coal reserves in 1997 (x 10^6 tons) Source: World Energy Council, table published by the BP Statistical Review - * Proven Reserves

Mineral coal is the most used fuel in the world for generating thermoelectric power. It is the main electricity generation source in the United States and China and its consumption is expected to increase in India.

According to projections by the International Energy Outlook 2000, by 2020, China and India will be responsible for 33% of the increase in world's energy consumption and for 97% of the increase in coal consumption.

One of the world's major concerns refers, however, to the quality of coals and their environmental impacts.

In this respect, countries such as the United States, one of the major users of coal as a source for generating electricity, invest significant funds in a program for developing clean technologies, the so-called "Clean Coal Technology Program".

The future of electric power generation in the world with a meaningful share in the energy matrix, depends necessarily on the large-scale development and application of efficient clean technologies that permit marketing low quality coals (with a high ash and sulfur content).

World trends of electricity generation growth point to a significant rise in coal consumption. To this end, adopting clean technologies becomes essential, particularly for the use of inferior quality coal.

World energy matrix and the trends of the coming decades

The planet's economic development leads to a natural growth of electric power demand, despite all efforts to improve the efficiency of technologies for generating energy.

International Energy Association – IEA projections of demand, highlighting the conventional energy sources, shows that only Natural Gas (NG) and Coal will be the major sources responsible for this significant growth of electric power generation in the future two decades (until the year 2020) projected to the order of 50%, and increasing from the current 14TWh to 26TWh.

It also projects that up to the end of the 21st century coal will continue to be the world's largest primary energy source.

Definition of Low Grade Coals and their Availability at World Level

The terms used for describing the quality of coal vary from country to country. This is due to the variable and heterogenic nature of coal, as well as to the different criteria adopted for its several industrial uses.

In simplified form, coals are divided into two general categories: hard or black coal and soft or brown coal. These categories are sub-divided into anthracite, bituminous, sub-bituminous and lignite coal, according to their age (degree of carbonization or rank of coal).

The content of fixed carbon, its heating value and inherent moisture indicate their rank but don't define it precisely. Standards vary from country to country and there are often cases of different limits overlapping.

Better quality coals are the type marketed internationally. Coals are considered to be of low quality when they have a high content of ash, moisture or sulfur. Such coals usually have a heating power below 16 MJ/kg (3822 kcal/kg).

Because these coals have a low energy content, their use is limited to the vicinity of their mines in order to minimize transportation costs. Typically they are used in run-of-the-mine thermoelectric plants.

Approximately one third of the coal produced in the world, except for China (WEC 1988), is low-grade. It is produced in about 28 countries and is a major coal consumption segment with a significant market in the regions where it is employed.

Environment vs. Development

The world witnessed an extraordinary, but not homogeneous, growth in the economy, especially in the second half of the 20th century. This was the result of development, the availability of technologies, and access to the comforts of the modern world due to a significant increase in energy consumption, particularly in First World countries.

Until the middle of the second half of the 20th century, a complete lack of attention was given to environmental questions in the productive chain of hydroelectric and thermal energy, the latter with dominant use of fossil sources. Thus, the soil, principally in mining and fuel processing regions, as well as the water in the vicinity of thermoelectric plants, were contaminated, the latter due to the contamination of rivers and subterranean water. The air suffered from acid rain resulting from various oxides, especially sulfur and nitrogen, and various particles, as well as from the so-called greenhouse effect caused by the emission of carbon monoxide, dioxide, etc. These emissions are some of the villains in the aggression to the environment.

Concerned with the growth of supply and demand of energy, the world turned its attention to environmental questions linked to energy production.

Thus the Kyoto Protocol was signed in 1997. Among other provisions, it defined targets for compatibility of development with the environment, referring specifically to energy generation vs. environment.

Controversial questions, particularly with regard to the greenhouse effect, have so far not been given their due attention by First World countries although it is they that have the greatest need of energy, especially of fossil origin. They are the main culprits of global impacts on the environment.

The importance of the fossil fuel share in the world energy matrix led to major discussions at the Rio + 10 Conference, an event recently held in South Africa. The targets set in the Kyoto Protocol were reconfirmed and the commitment “of the world with the world” to the effect of better equating world growth with the needs of the environment, were reinforced.

Meeting the needs of those who are excluded from the benefits of electric power is essential since lack of this commodity increases their penury, the worst environmental social impact.

Energy for poor or emerging countries must be financially bearable, environmentally correct and available to all. How can the high environmental costs that increase the price of energy be made compatible with the cost that low income populations can bear?

The strong social-economic impact of coal-fired energy generation, especially of low grade coals used as domestic fuel, leads to the need for mechanisms that foster clean combustion technologies. Recent Brazilian legislation (Law 10.438 from April 29, 2002) is an example of such a mechanism: it resulted in pro-rating this onus among all the more prosperous consumers. On the other hand, financing incentives of projects for clean coal technologies are so far unavailable to developing countries.

Environmental cost for emerging countries

The cost of preserving the global environment is too heavy for emerging countries which, as it happens, were not the main culprits for the situation faced at world level. It is, therefore, not fair that these nations should be obliged to defray the costs demanded by the world community in the same proportion as those that are mostly responsible for the planet's degradation. Under such circumstances, they would be forced to use their already scarce funds they would otherwise assign to lever other social-economic development factors.

Environmental restrictions

Meeting the energy demand growth needs in any of its forms must be undertaken in an environmentally responsible manner and from the angle of development. Thus, the environmental questions resulting from the expansion of energy production must not be considered as restricting to development; in the global context they must be seen as priority vectors of technological development.

Emission standards vs. environmental standard

The environmental legislations of various countries, including Brazil, set emission standards for all industrial processes. In regard to mineral coal, Brazil is particularly motivated to setting basic norms in the culture of developed countries where this fuel is much more intensely used in the energy matrix.

This stand, which does not take the situation of the Brazilian energy matrix, nor the local environmental scenario into consideration, has been the major reason for the higher costs of coal-fired generation, causing a disproportionate loss to the corresponding investments.

This leads to the following discussion on the matter:

In the scenario of emerging countries, what targets could be set to equate the energy production expansion with the necessary preservation of the environment? Up to what point should the expansion of electric power which they will contribute a negligible amount for many future decades compared to the global emissions of First World countries?

Technologies that make the use of low quality coal viable.

Since the sixties, endeavors were made to achieve greater efficiency resulting in less fuel consumption by looking into the possibility of using poorer fuel (of lesser cost), as well as to preserve the environment by employing fossil fuels. These efforts motivated the development of clean technologies in First World countries, which are the countries that have the greatest demand for energy, especially energy of fossil origin.

The development of clean technologies suitable for low-grade coals

The development of these clean technologies suitable for cheaper fuels such as low-quality coals has its major core in the American Clean Coal Technology Program. Through special sub-programs that involve private enterprise and public administrations, 24 project proposals were submitted to the US Energy Department – DOE at a cost to the order of 535 million dollars, 251 million of which were invested in a sinking fund by the Federal Government.

The costly transfer of know-how

Aside from adding competitive advantages to the U.S. economy as a whole, the Clean Coal Technology Program furnished know-how to the main American producers of equipment. Let us underline that access to these new technologies by Third World countries implies large investments in the acquisition of a know-how whose development was subsidized by American manufacturers.

The scenario faced by investors in Third-World energy projects is really ironic: environmental marketing by clean technology holders, articulated with the media in general, specifies pressure on public opinion and, therefore, on local environmental agencies to observe environmental restrictions similar to those imposed in countries where these technologies were developed and generate protection demands not in line with the local environmental reality. Third-world countries suffer access restrictions to credit since international financing agencies oblige solicitants to meet environmental performance standards involving costs not compatible with the social-environmental reality of the countries where the projects are intended to be implemented.

If it is really internationally agreed that environmental performance of energy projects standards should be generally applied, the models adopted internationally must be modified in order that technology and know-how transfer is not as onerous as at present. Mechanisms that facilitate access to funds through traditional financing organizations must also be introduced.

Creating and using incentives and funds to permit access to clean technologies

Creating international funds to make access to clean technologies viable could be an alternative to the above. Such funds would be maintained by countries whose contribution to global environmental impacts is above the defined limits. This would result in a more balanced world economy and have the additional benefit of large scale use of cheaper energy sources in an environmentally sustainable manner.

Some of these mechanisms are already being adopted, for instance carbon credits.

Mechanisms for financing the technological development of Third-World countries and diversification of the energy generation matrix – the Brazilian model

On April 29, 2002, Brazilian Congress approved Law 10,438 which introduced a mechanism that fosters the diversification of Brazil's electric power generation matrix. This mechanism, called "Energy Development Account" (Portuguese acronym CDE) permits that all electric power consumers of interconnected systems – except Brazil's Northern Region – contribute to a fund that will foster the generation of electricity through renewable sources, clean coal, and the implementation of gas pipelines in regions that have none.

This Law allows Brazil to count on an additional approximate 3000 MW generated with coal produced with clean coal technologies. Allows also that, at the first stage, up to the year 2006, 3000 MW of renewable sources will be constructed and at a second stage, in the next twenty years, these sources will meet 10% of Brazil's electricity consumption.

So-called sectorial funds were recently created in Brazil for developing technologies. They, together with other public and private sources and the compulsory inflow from private enterprise, are to finance Brazil's technological development through combined efforts of public and private companies, universities and research and development centers.

Sectorial oil and natural gas, as well as electric power funds and the "yellow and green" (the colors of the Brazilian flag) fund are available in the energy sector.

These contributions are annual and in order to benefit from them companies must annually submit R&D programs with their projects.

Available/recommendable technologies and technologies under development for low-grade coals

The use of poor coals in an environmentally sustainable form requires that the productive chain be seen as a whole and not be restricted to the actual generation of energy.

When coal is used as a primary energy source, starting with its mining, and there may be use for other ores associated to coal, such as clay, priority must be assigned to the use of raw coals – ROM, or even to burn rejects using for the environment recovering of old mine areas.

Thus, technological concepts to be adopted would have to endeavor to obtain maximum use of the energy input, including by-products like the steam resulting from co-generation, ash and the products generated through treating liquid and gaseous effluents.

Combustion in a fluid bed has been highlighted at world level as the best technology for energy use of low-grade coals, and its performance is considered to be compatible with the environment. For the next generation of electric power coal based generation technologies, the integration of gasification in the combined cycle is visualized, associating gas with steam turbines. This would result in greater global efficiency than that of conventional combustion.

Although this technology and fluidized combustion under high pressure are relatively highly developed, they still need large specific investments in research and development before marketing can be considered.

Use of by-products – ash, co-generation steam, fertilizers, gypsum, etc..

The use of coals as a primary source for generating electric power, especially those considered to be of low quality, encompasses the advantage of making use of lower cost fuels.

However, before coal can compete with other energy sources, considering that its use requires a significant investment to mitigate environmental impacts, it should be viewed, not only as a primary energy source for producing electric power, but as a starting point for a productive chain where by-products and residues of its use in the generation of energy play a major role, both economically and environmentally.

Thus, aside from the chief product – electric power, co-generation, i.e., industrial use of the steam generated in thermoelectric plants, the use of ash as raw material for construction material (cement, tiles, as an element in highway construction, production of gypsum for removing sulfur from combustion gases - when the reagents used are limestone or fertilizers (in which case the reagent is ammonia) they contribute in questions connected with environmental preservation and crucially in the competitiveness of coal with other primary sources.

Brazil’s experience in the use of low-grade coals

According to its characteristics, high ash (>50 %), sulfur content (between 0.5% and 8%) and moisture (5-16%), Brazilian mineral coal is classified of low quality.

Such coals are usually washable which permits the reduction of ash and sulfur. However, Brazil’s principal and largest national mine, the Candiota located in the south of the State of Rio Grande do Sul, is not greatly washable. It is therefore exclusively used in thermoelectric plants in the vicinity of the mine. Its ash content is 53%, its sulfur content 1.5%, and its humidity is up to 18%.

On the other hand, coal processing through washing causes environmental problems by generating major quantities of liquid and solid residues. Therefore, large investments in preserving the environment are required.

In Brazil, coal is found in its southern states: Rio Grande do Sul, Santa Catarina and Paraná. Its use - generation of electric power – is also concentrated there.

The figure below shows the location of Brazilian mines and of thermoelectric plants.

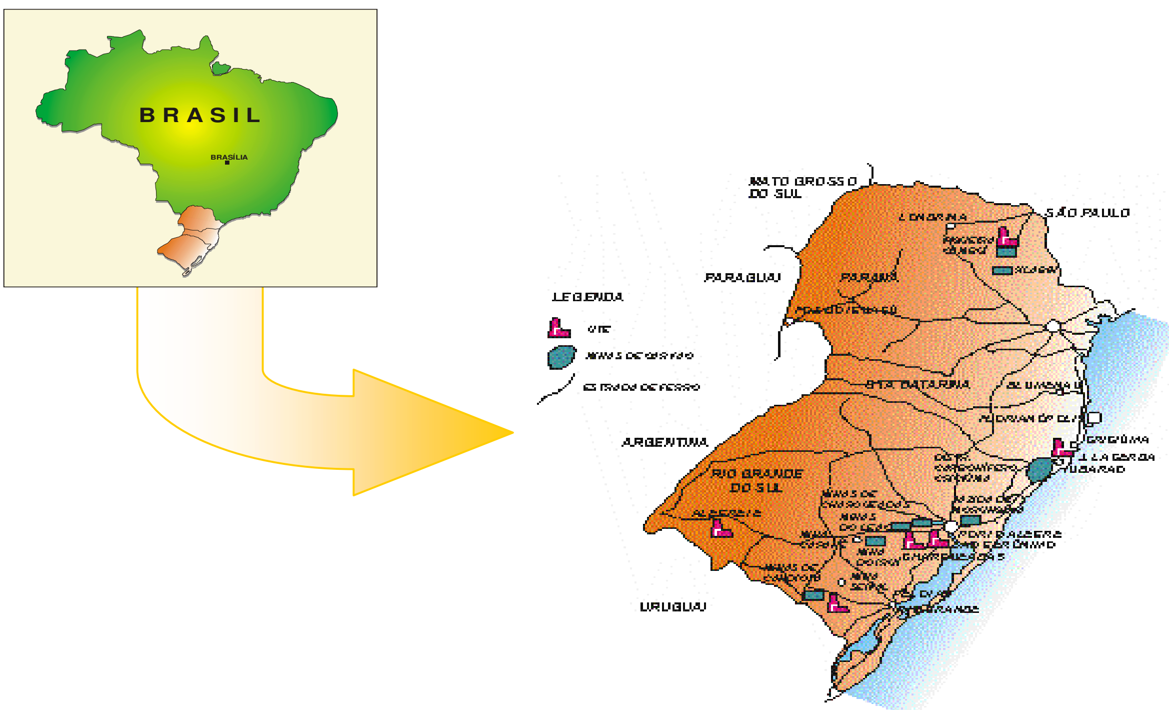

Figure 4 – Location of coal mines and of coal-fired thermoelectric plants in Brazil

Brazilian thermoelectric plants in operation are based on simple cycle technology – vapor cycle through, mainly, pulverized combustion (PC)

The table below shows the coal-fired thermoelectric plants operating in Brazil.

Power Plant	Sate	Nominal Capacity MW	Type	Coal
Presidente Médici Fase A	RS	126	Pulverized Coal	ROM
Presidente Médici Fase B	RS	320	Pulverized Coal	ROM
São Jerônimo	RS	20	Mobile Bed Combustion	Washed
Charqueadas	RS	72	Pulverized Coal - Co-generation	Washed
Riocel	RS	30	Pulverized Coal - Co-generation	Washed
Copesul	RS	50	Pulverized Coal – Co-generation	Washed
Jorge Lacerda A	SC	232	Pulverized Coal	Washed
Jorge Lacerda B	SC	263	Pulverized Coal	Washed
Jorge Lacerda IV	SC	363	Pulverized Coal	Washed
Figueira	Pr	30	Pulverized Coal	Washed

Table 2 – Coal Power plants in operation in Brazil

The ash generated in these units is used in the cement industry due to its pozzolanic property and, in some cases, co-generation is used.

The following units are planned to enter into operation in the next few years:

Power Plant	State	Nominal Capacity (MW)	Type	Coal	By-product
Jacuí	RS	350	Pulverized Coal	Washed	Gypsum
SEIVAL	RS	500	Pulverized Coal	ROM	Ammonium Sulfate
Candiota III	RS	350	Pulverized Coal	ROM	Gypsum(?)
Figueira	PR	127	CFBC	Washed	
USITESC	SC	350	CFBC	ROM + Processing Rejects	Ammonium Sulfate

Table 3 – Coal Power Plants planned for Brazil

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