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Whenever a new liquid fuel is introduced within the energy matrix it encounters a distribution network that is already in place, and with logistical costs that are considerably lower than they would be for any new alternative purpose-built network. The entry price to be paid is reduced if there is an agreement to stick to the pre-existing system. This, effectively, means that the financial return always stays subordinate to established hegemonic interests.

The introduction of alcohol fuel went through this same process, reinforced at the time by the fact that Petrobras had a legal monopoly. There was negative reaction to the spread of the mini-distilleries and an eventual consolidation around a greater proportion of anhydrous alcohol being mixed in gasoline and the compulsory marketing of the hydrated alcohol inside a single logistical system for fuel distribution. It is only now, thirty years later, with the technological innovation of the Otto flexible engine, that there is a possibility for the price of alcohol to be freed from monopoly and set outside a sales system with coupled prices, and for each producer to be free to choose a distributor of his choice.

Effectively, however, there is still a monopoly because the economies of scale made possible by the logistical network and the existing pipes and port terminals, which are exclusive to Petrobras, sustain its competitive advantage. (Figueiredo, 2005). The regulating agency – Agência Nacional do Petróleo (ANP - National Petroleum Agency) – also recognizes the strategic advantage of a monopoly that, until now, has maintained a heavy volume of investment in oil exploration; developed sophisticated technological expertise in deep water exploration; and, bearing in mind the limitations of Brazil's infrastructure, developed a logistical network that guarantees the distribution of fuel to all the national territory.

The question that now arises is whether biodiesel, as another alternative to fossil fuels, should be introduced inside the monopoly system or outside of it, as a truly competitive product. The present system of auctions, in large volumes, as a way of paying the subsidies needed by the producers of vegetable oils, makes the product a prisoner of the de-facto monopoly held by Petrobras. The technological alternative, the H1, consolidates the total dependence of the fuel's distribution because of its obligatory passage through Petrobras refineries, thus putting an end to the autonomy of the esterification plants and, consequently, with marketing alternatives such as B100, analogous to what happens today with alcohol fuel for flexible engine vehicles.

We shall see later that there are technical restrictions that prevent current diesel engines from functioning well using pure biodiesel, but they are not absolute and, most importantly, can be overcome by means of a directed program of technological innovation. So, within the existing regulatory framework, biodiesel is a mere additive to conventional diesel limited to a 5% mix and its price dependant on an intricate set of interests within the existing de-facto monopoly.

Prices, taxes and state regulation of fossil fuels

The presence of a state monopoly in the oil industry was very important in the history of Brazilian industrialization, as much because of the economic foundation of economies outside of this strategic sector as because of its role as a tool for concentration of state funds. From the first, the price of gasoline relative to diesel was fixed so as to generate a large profit to pay for a cross subsidy sufficient to allow for a low price in the other. The price of diesel was deemed to be part of the costs of the whole industrial structure and as such had to be kept low to facilitate industrialization by the successive substitution of imports. For decades we have kept gasoline prices above international market value and diesel prices below average value, roughly, 20% above and 20% below, respectively. This helped a great deal in obtaining the returns needed by alcohol fuel as it was protected by the gasoline price ceiling but now, for biodiesel, it complicates things a great deal because of the low price floor of diesel prices.

To make matters even more complex, the current national fiscal crisis has transformed the fuels market into a provider of revenue for both federal and the state governments, increasing the taxation load on the final fuel price. Recently, the introduction of the “CIDE” (Contribution for Intervention in the Economic Domain) - an additional tax that helps prevent arbitration between the relative domestic and international prices – has made the value of the cross-subsidies within the monopoly more transparent. Finally, a complicated matrix of rail and road freight costs completes the final price structure paid by the consumer at the filling station (intentionally forgetting the formation of natural gas prices within this matrix).

Everything added together, the price at the pump reflects between 10% and 20% freight, between 30% and 40% tax load, and, in the case of diesel, a transfer of 20% partially compensated by a similar addition to the price of gasoline (with the added hike of more than 20% alcohol in the mixture).

Sugarcane alcohol is today the only renewable fuel that does not need subsidies to enter the international fuel market; in the domestic market it gets that extra boost through the gasoline price protection ceiling. Biodiesel would have to come into the matrix carrying the onus of the low price floor applied to diesel fuel prices, which is the justification for the subsidies implicit in the system of auction purchase of supply contracts.

This is the system that ensures biodiesel is trapped within the de-facto monopoly.

What is the opportunity cost for biodiesel in the Brazilian market? As we import diesel oil to supplement internal supply, the cost of the imported raw material is the basis of the opportunity cost; the transport costs would also have to be included. The tax transfers are a kind of compensation paid between those citizens that pay for the diesel and those who benefit more from public and state expenditure, including those who hold supply contracts from ANP's auctions. If total tax exemptions were applied to the marketing of biodiesel, the transfers would happen automatically, without the intermediary of auctions; so that producers located far away from the refineries would also receive the cost of freight built into the price of the diesel. To the producer of biodiesel would be paid the opportunity cost of diesel, increased by an additional proportionate transfer which those already benefiting directly from public expenditure already receive. The auctions are, in practice, a way of limiting entrance into the monopoly market, rationing part of the subsidy and of the transfer of monopolistic profits that is built into the remuneration structure of the whole Brazilian fuels matrix.

In search of the ideal raw material for biodiesel (and the ideal engine too)

Adapting biodiesel to the existing fleet of diesel engines presents some problems that compromise a small part of its efficiency when using diesel alone. Some of its viscosity characteristics improve performance, but others such as solvent and oxidation are still not properly treated for use of B100 (100% biodiesel). For the most used engines, a thorough clean of all accumulated deposits would be appropriate plus a change of plastic and rubber components that can degrade when in contact with biodiesel. These facts suggest a path for technological adaptation similar to that followed in Brazil for cars run exclusively on hydrated alcohol (Kojima & Johnson, 2005, p77). Small percentage mixtures, 2% to 5%, generate little gain in reduction of particle emissions but when mixed at 20%, with more significant gains, the additional costs are of concern to the regulating agency, especially when suggested for large metropolitan centers. (Renewable..., 2004). For this reason, many of the ongoing trials are recommended for use in captive fleets (Raneses et al, 1999). There is evidence that diesel engines of older generations, with combustion prechambers, are a lot less sensitive to those characteristics of biodiesel instability, but they are no longer in modern production lines (Kogima & Johnson, p.85).

If there is a need for technological adaptation, we are still not in a position to initiate massive programs, but only pilot projects and systematic expenditure in research and development of technology. In turn, the costs of production suggest that there is high dependency on the raw-material used,

approximately 85% of the manufacturing cost. In other papers presented at the Bioenergy Seminar of IEA/USP, it was evident that castor (*mamona*) presents the highest costs and oil palm (*dendê*) the lowest. Coyoli palm (*Macaúba*) and pine (*pinho manso*) are among those with the biggest yields, rape (*canola*) and sunflower (*girassol*), are in an intermediate range. Soya, always among the viable options, produces four times more meal than oil, therefore, any larger scale program must take into account that the market price of meal may fall as well as the price of the bean (Raneses et al., 1999). Many of these alternative plants, especially those that are not used as food for humans, still depend on further research and development to find the ideal form for cultivation on a large scale. In economic terms, with crude oil at US\$60 and US\$70 per barrel, not even palm oil is an ideal raw material for a competitive biodiesel, and, anyway, it would mean diverting from human consumption the vegetable oil acknowledged as being the cheapest.

Implications for the regulation of future biodiesel

If the cost of the raw material is such a high portion of the production cost, there is not much room for economies of scale in the industrial unit, as there is with ethanol from sugarcane. The largest units that are being installed in Brazil stem from the system of subsidy auctions, and from the fact that deliveries to Petrobras refineries demand a high logistical cost in which some advantage of scale may appear.

The opportunity cost of diesel is very much higher in the regions furthest from the refineries; the pilot project and technological research should be specific to each region because there is reason to suppose that the ideal raw material will be different for each of them. Amazon palm oil should not be distributed as biodiesel in the metropolitan centers of the Southeast of the country. No raw material should travel more than two hundred kilometers to find the final consumer of biodiesel, yet castor bean today is probably traveling more than 1,500 kilometers.

Incentives for technological innovation and research into genetic improvement of potential raw materials for biodiesel are fewest in the current auction system. Given guaranteed profits for castor bean (lowest rate of agricultural productivity and a low conversion ratio from fossil to renewable energy), all other raw materials are viable, within the present system of auctions. Locking the program inside the de-facto monopoly leads to regional concentration and partnership strategies developed to win at auctions rather than to take the risks that would develop a winning technology for the future.

We need, therefore, a new regulatory framework for the biodiesel of the future.

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ABSTRACT – The regulatory framework for fuels in Brazil is an effective monopoly, with matching prices for close substitutes. Biodiesel prices are unattractive because domestic diesel prices are below international relative oil prices, transportation logistics burden furthermore with unnecessary routes designed for fossil fuels, beyond heavy indirect taxation. An alternative framework, without taxation, for short distance supply, with a large variety of raw materials is better suited for technological innovation.

KEYWORDS: Fossil fuels monopoly, Biofuels, Biodiesel, Market regulation, Technological innovation.

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