

Is Brazilian biofuels experience a model for other developing countries?

With growing interest worldwide in the use of liquid biofuels in the transport sector, ethanol and biodiesel are considered the best alternatives. Rising oil prices, environmental concerns and interests in energy security have driven countries to look to biofuels production as a potential solution. Other driving forces are the need to stabilize commodity prices and cut down on agricultural subsidies. This paper describes the Brazilian experience with large-scale ethanol production.



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Global ethanol production in 2005 reached 44.9 billion litres (or 44.9 GJ), roughly equivalent to 22.4 million tonnes of oil equivalent (toe), while the production of biodiesel was 3.8 GJ, equivalent to 3 billion toe. Overall, ethanol consumption in 2004 represented just about 2 percent of global gasoline use (Lew Fulton – International Energy Agency: quoted at F.O. Licht World Ethanol & Biofuels Report, July 2005, 3 (21)). The main producers of ethanol are Brazil and the USA, their output in 2005 amounting to almost 80 percent of world production. The Brazilian experience in the large-scale production of biofuels is mainly based on ethanol. Large-scale production of ethanol as automotive fuel started in 1975. Since then, ethanol production has increased 27 fold, the production of ethanol (anhydrous + hydrated) reaching 16.5 GJ in 2005. Anhydrous ethanol is used blended with gasoline (all gasoline sold currently has 20 percent of ethanol, volume basis) while hydrated ethanol is used in neat ethanol vehicles (recently, in flex-fuel vehicles – FFVs). In Brazil, ethanol covers about 30 percent of the demand by automotive transport. Ethanol is a competitive option to gasoline and no subsidies have been applied since the late 1990s.

How important can biofuels be for developing countries?

In June 2005 the United Nations Foundation launched the Biofuels Initiative to promote the sustainable production and use of biofuels in developing countries. The UN Foundation states: «Biofuels have the potential to alleviate poverty, create sustainable rural development opportunities, reduce reliance on imported oil, and increase access to modern energy services» (United Nations Foundation: *The United Nations Biofuels Initiative*, June, 2006). Many developing countries in the tropics have comparative advantages for producing biofuels thanks to land availability, adequate weather conditions, and a sufficient workforce. Biofuels production offers a high potential to create jobs, especially in rural areas.

Many developing countries are net importers of crude oil (and/or gasoline and diesel) and for these countries biofuels use can bring the combined benefit of enhancing energy security and reducing high foreign currency outlay (see also article by Suzanne Hunt, on page 30). For some African countries, imports of oil and oil derivatives account for up to 80 percent of their foreign exchange expenditure. Apart from reducing energy imports, these countries could even become exporters of biofuels should an international biofuels trade actually become reality.

Biofuels production would induce economic growth and would certainly create jobs in a new producer country. Taking the Brazilian experience as an example, job creation associated with ethanol production requires a very low investment compared to other economic activities (e.g. 10 US\$/job in the sugarcane industry, the corresponding investment in the consumer goods sector being four times higher and twenty times higher in the chemical/petrochemical industry). It is estimated that the ethanol industry in Brazil created about one million direct jobs (some 50% of which are in sugarcane production) and 2.5-3.0 million indirect jobs. However, these figures reflect the relatively low mechanization in agricultural production and the very limited automation at the industrial level.

From the environmental perspective, blending gasoline with ethanol offers the benefits of phasing out lead, because ethanol has higher octane grade than gasoline (e.g. 109/98 versus 95/80). This is extremely important wherever leaded gasoline is still in use, as is the case of many African and some Asian and Latin American countries (Valerie Thomas and Andrew Kwong: *Ethanol as a lead replacement: phasing out leaded gasoline in Africa*. Energy Policy, issue 29, 2001, pages 1133–43).

The automotive use of ethanol also reduces emissions of particulate matter, carbon monoxide, and toxics, and causes less ozone formation. Consequently, ethanol use contributes to improving air quality in large cities. These advantages are even more relevant when the existing

fleet is relatively old, as is the case in most developing countries. Introducing more efficient emission control systems in vehicles (i.e., electronic management injection, catalytic converters and canisters) could generate roughly the same overall reduction in exhaust emissions no matter what fuel is used. But when these control systems do not exist, or do not operate well, ethanol would bring greater environmental advantages.

Large-scale use of biofuels is one of the main strategies for reducing greenhouse gas (GHG) emissions. Although developing countries do not have targets under the Kyoto Protocol there are two main aspects to be considered. First, under the Clean Development Mechanism (CDM), developing countries can sell credits to countries with reduction commitments. Considering a typical Brazilian figure of 2.7 kilograms of CO₂ equivalent avoided emissions per litre of anhydrous ethanol, biofuels use could represent additional income of US\$ 0.02-0.05 per litre (supposing CDM credits in the range US\$ 7-20 per tonne of CO₂ equivalent). Second, the effects of climate change are already being felt most in developing countries and it is important to start acting now.

Challenges for new biofuel producers

Good planning is the first and foremost challenge for the large-scale production of biofuels. The biomass sector has far more actors than the conventional, well-established energy sectors (e.g. oil and electricity). The first ten years of the Brazilian ethanol program took place under a military system which made planned actions easier to implement. Nevertheless, despite reasonably well coordinated actions more than 30 years after the beginning of large-scale production in Brazil, the poor level of planning is still a significant factor in the current efforts to enlarge production capacities.

The development of a biofuels system requires a reliable set of suppliers of goods and services. In the planning process, the necessities of the whole production chain have to be identified upstream. The sugarcane industry in Brazil was already well established when large-scale production of ethanol started, but this is probably not the case for most developing countries. Biofuels production and use must be sustainable. Hence competition between food and fuel crops and harm to ecologically sensitive areas have to be seriously considered in the planning process. Even in a country with a large availability of land, as is the case in Brazil, regulation on land use seems to be necessary, and Brazil is still fac-

ing problems regarding this issue. It is well known that control is expensive and seldom efficient, especially in developing countries, and innovative ways of abuse prevention have to be developed. The second challenge is to make biofuels production an economically feasible alternative to fossil fuels within a foreseeable future. Ethanol production costs in Brazil have been drastically reduced thanks to improved technologies both at the agricultural and at the industrial level, and due to the enlargement of the scale of production.

Another important factor for the competitiveness of biofuels is production diversification. Brazil's concept of biorefinery has resulted in the production of second-generation biofuels. Producers can take advantage of the flexibility between the production of sugar and ethanol serving the very competitive international sugar market while adapting the domestic ethanol market to match supply conditions (the ethanol blend has been adjusted over the years, the advent of flex-fuels vehicles is even more advantageous). Many new producer countries will not be able to take this approach, at least in the short-term. On the other hand, diversification potentials associated with the use of by-products should be further explored. Deriving electricity from by-products such as sugarcane bagasse, makes a substantial difference both with regard to the energy balance and to cost reduction. Commercially available electricity generation technology can produce up to 10 times more electricity than needed to operate a typical sugar cane mill. Depending on the specific conditions of each country, surplus electricity production can be an important revenue. Enforcing social and environmental laws is another important challenge for many developing countries. Giving priority to producing biofuel could easily lead to legislation being abused or disregarded. Biofuel production has to be based on the principle of social and environmental sustainability.

The Brazilian experience as reference

Being the main biofuel program in a developing country to date, Brazil's experience as the second largest producer of ethanol in the world should be critically analysed. The ethanol program started at a time when everybody expected oil prices to remain at a high level forever. The wide-ranging subsidies granted to raise production resulted in an installed capacity larger than necessary in the short-term. Worse: these advantages incited the entrance of producers not really interested in the future of the biofuel market. While subsidies are important to

foster the initial stages of a renewable energy program, it is important to simultaneously impose conditions and define time limits. These aspects were not appropriately catered for in Brazil.

In the mid 1980s, the Brazilian government halted support to the biofuel program, probably at a time when production was not yet fully competitive. Producers blamed this incorrect timing for the supply crisis in 1989-1990, but the main reason was the lack of correctly planned support policies.

For almost ten years, the domestic ethanol market was left to its own. However, the sugarcane sector was modernized and in the late 1990s, the markets for fuels and sugar cane were deregulated. Ethanol was available to the Brazilian fuels market at a lower and more competitive price. In the meanwhile «flexible-fuel vehicles» (FFVs) have reached the Brazilian market, and will no doubt increase the use of ethanol in the transport energy matrix in the years to come. Although FFVs are an excellent solution for an ethanol market as big as Brazil, they are not favourable options for a new producer country. In view of the lack of infrastructure in many countries, ethanol should be introduced through fuel blends, and the ethanol share should be defined as function of the local production capacity.

In a new producer country, ethanol production capacity could be expanded also to take into account a potential international market to come; although decisions here have to be taken very carefully. Most biofuels markets in developed countries will continue to be protected for many years. Moreover, on such a narrow market only a few countries will be really competitive in terms of prices and product standards, including certification. Reaching international production standards is one of the big challenges for new producer countries. Cooperation between producer countries might be a way of achieving better representation on the biofuels markets. Cooperation between developed and developing countries also should be explored, mainly on defining production standards.

Large-scale ethanol production has a great potential for many developing countries but it is naïve to expect that a biofuels program would automatically resolve structural problems such as fair wealth distribution and reducing endemic poverty. Nevertheless, a biofuels program, if well planned and developed can be part of the evolutionary process that society needs. Brazil's ethanol program was created to help reduce economic problems but has become much larger than was originally intended. The Brazilian sugarcane industry aims to become an energy producing industry, and this requires a differently managed long-term planning.