BRAZILIAN SUGARCANE INDUSTRY ASSOCIATION

ETHANOL • SUGAR • ELECTRICITY

20 April 2010

**MEMORANDUM**

TO: Bruce Babcock

FROM: Joel Velasco
Antonio de Padua Rodrigues
Luciano Rodrigues
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RE: Brazilian Ethanol Projections

This memo provides you with UNICA's projections for Brazilian sugarcane ethanol production, domestic consumption, and potential exports over the next five years (2011-14).

You asked:

> *"I need the maximum amount that will be produced by 2011 and 2014, the maximum amount that can be exported, and the maximum amount that will be used domestically. Then I need most likely production and domestic use. From these figures I can then calibrate an export supply curve of ethanol from Brazil to the U.S. that is a function of the relative prices of ethanol."* (Email exchange on April 13th, 2010)

We have made our best effort to make as realistic projections as possible. We are reasonably confident about the projections and even more so confident about the underlying assumptions detailed in this memo.

A few caveats. Given the short time horizon of the exercise, we would caution about fluctuations in sucrose yields (Total Recoverable Sugars, or ATR in Portuguese), which can be affected by rains, as was the case last year. In the long run, the ATR evens out and has been increasing steadily but, in the short term, it could vary. Also, as detailed below, the industry's response to a drop in the tariff will take some time to be fully realized, since it takes three years for a new mill to come online and then almost four years for full production capacity. Finally, in our projections we have assumed that Brazil will not alter its sugar production/export volumes significantly. As you may know, about 84% of the country's sugarcane processing mills have some flexibility in sugar vs. ethanol output. Given the impact on world sugar prices due to Brazil's market position in sugar production, we assume that Brazil will continue to meet its share of world sugar demand.

Bottom line: While Brazil will likely increase production of ethanol in response to U.S. reduction of the ethanol tariff, there will be a lag in response. And, over the medium period, as competition takes root, we would expect U.S. and Brazilian ethanol prices to converge.

## A. Ethanol Supply Scenario

To project ethanol supply in Brazil to meet domestic and foreign demand, we have analyzed the expansion of industrial capacity to produce ethanol, and the likely evolution of sugarcane crushing by mills located in the South-Central (90%) and North-Northeast (10%) region of the country.

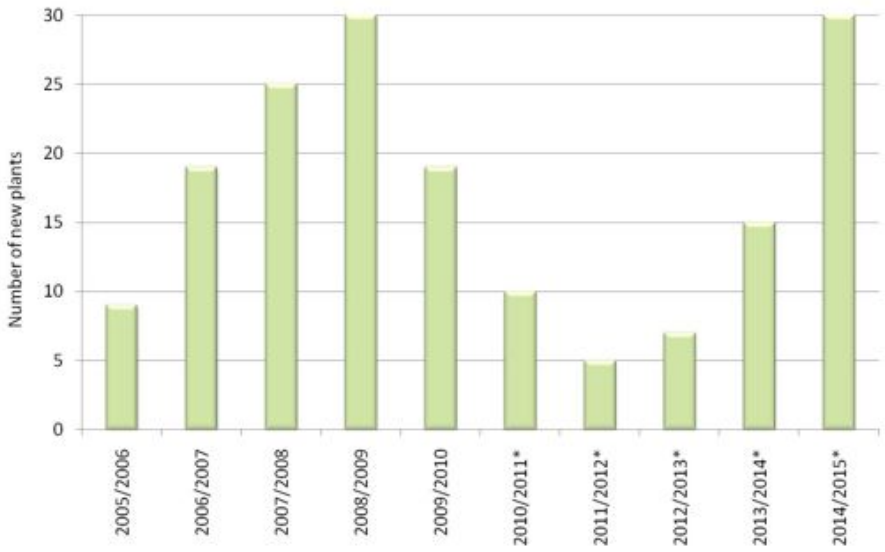
The projected values were obtained using as basis the following premises:

I. The U.S. eliminates its tariff on ethanol imports would create expectation of increased demand for sugarcane industry in Brazil and, therefore, induce the construction of new production facilities and capacity expansion in existing companies.

*Evolution of number of new Mills:*

II. The average time to build a new mill is 3 years. Therefore, even if the tariff were removed at the end of the year, a significant increase in the number of new production units in the country will not take place before 2013. Consequently, we estimate that, in addition to the 10 new mills that will come online this year, another 57 new mills could come online by until 2014. This is based on the hypothesis that in 2014/15 crop year, 30 new units will begin their operations, which would be consistent with historical record (observed in the sugar and ethanol industry in 2008/09, as a result of the 2006 demand boom). See Figure 1 below.

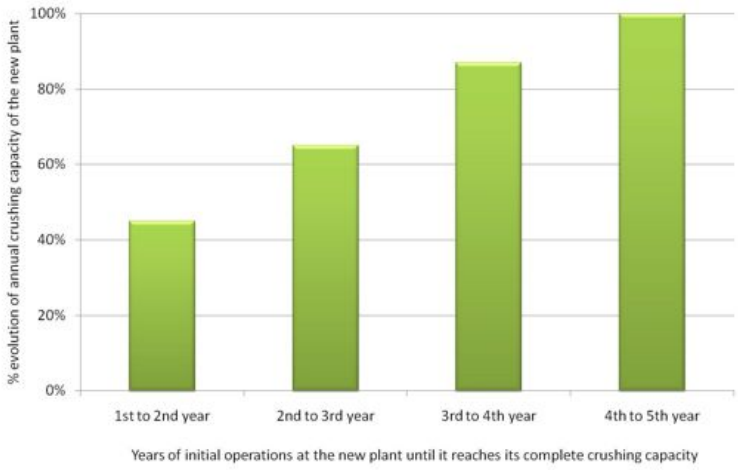
**Figure 1: Number of New Mills**




Source: UNICA. Notes: From 2005-2010 – actual observed values; 2010-15 are estimated values.

III. New mills have an average maturity of four to five years. In other words, it takes about four to five years to reach total production capacity, as Figure 2 illustrates. Also, we assumed that, on average, the full production potential of new units is 3.5 million tons per mill.

**Figure 2: Annual Percentage of Crushing Capacity for a New Mill**




*Mills already in Operation:*

IV. We have assumed an increase in crushing in traditional units (existing mills operating at capacity), except for the 2011/12 crop year. The current "aging" of the Brazilian sugarcane fields, and requirement for crop replanting, will reduce the area available for harvest in traditional producing regions in 2011. This explains the decrease of traditional mills for crushing, estimated at 2% for 2011/12 crop year. Thus, whatever the market outlook in 2011 (promising or not) may be, sugarcane crushing for next year is already pre-determined at about 690 million tons.

*Other Premises:*

V. An improvement in Total Recoverable Sugars (ATR in Portuguese) is projected, reaching 142 Kg of ATR per ton of sugarcane in the 2014/15 harvest;

VI. A production mix in favor of ethanol production was adopted, with sugar production remaining at levels currently observed in the South-Central region (between 32 and 34 million tons) and North-northeast (about 4 million tons).

Based on the above, UNICA's projects sugarcane crushing, sugar and ethanol (anhydrous and hydrous) production for Brazil's 2014/15 harvest year in Table 1 in next page. It is important to note that because of the lag between market signal (i.e., elimination of tariff) and the construction of new mills, any significant increase in supply would emerge only in 2013.

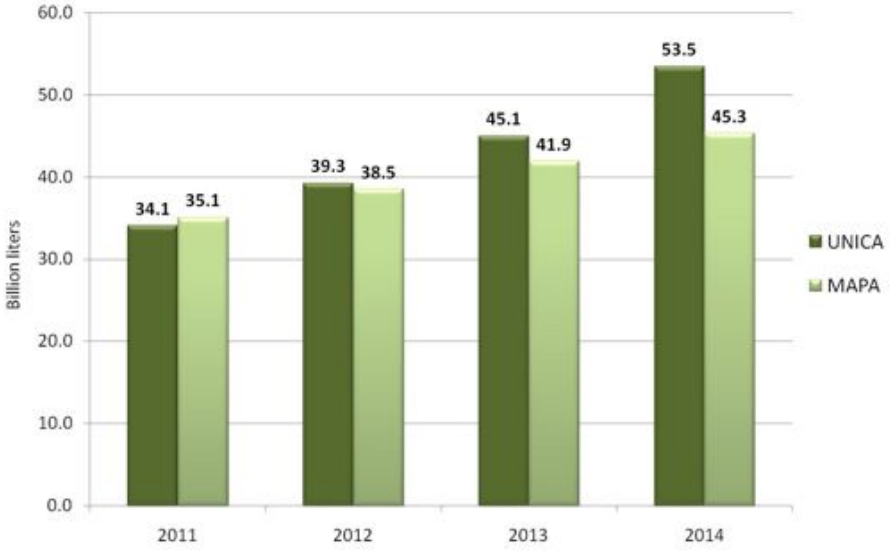
**Table 1.** Sugarcane crushing and ethanol and sugar production in Brazil

| Crop Year | Sugarcane crushing (Metric tons) | Sugar production (Metric tons) | Hydrous* Ethanol production (Liters)* |
|---|---|---|---|
| 2005/2006 | 387,441,876 | 25,905,723 | 16,288,755 |
| 2006/2007 | 425,535,761 | 29,882,433 | 18,081,133 |
| 2007/2008 | 495,723,279 | 31,026,170 | 22,884,059 |
| 2008/2009 | 569,062,629 | 31,049,206 | 27,920,027 |
| *2009/2010* | *606,500,000* | *33,031,000* | *26,009,124* |
| *2010/2011* | *657,508,732* | *38,490,000* | *29,743,160* |
| *2011/2012* | *689,943,536* | *36,400,000* | *34,115,977* |
| *2012/2013* | *747,804,739* | *36,400,000* | *39,313,465* |
| *2013/2014* | *818,903,028* | *37,400,000* | *45,062,394* |
| *2014/2015* | *921,572,270* | *38,490,000* | *53,490,219* |

Source: UNICA. Notes: Brazil uses mostly hydrous ethanol. However, only anhydrous can be a gasoline blendstock. In order to convert hydrous ethanol (near 5% water content) into anhydrous (near zero water) multiply by 0.9582

UNICA's estimates are higher than those published by the Brazilian Ministry of Agriculture (MAPA), as demonstrated in Figure 3 below. This difference arises from the different ethanol supply scenarios analyzed by these institutions: while UNICA's projection are based on the *optimistic* assumption of the elimination of U.S. tariffs imposed on imported ethanol, while MAPA's estimates are based on a more realistic scenario (e.g., continuation of trade barriers for ethanol).

**Figure 3.** Comparative of ethanol production projections; UNICA vs. MAPA




Source: UNICA, MAPA.

## B. Domestic Demand for Ethanol Scenario

In order to project demand for fuel ethanol in Brazil, we made the following assumptions:

I. Average income elasticity[1] is 1.3 for sale of light vehicles, given a projected GDP growth of about 5%, as drawn from Brazilian Central Bank's projections in Table 2;
II. Flex fuel vehicles corresponds to 92% of new light commercial vehicles sales, which is current averages in recent past;
III. Equivalency between motorcycles and vehicles consumption is 3 units. That is, the fuel consumption of one light vehicle equals the amount demanded by 3 motorcycles;
IV. Mandatory blend of anhydrous ethanol in Gasoline remains at 25%, as required by existing legislation, which allows executive to set blend between 20-25%; and
V. Motorcycles sales remain constant as well as the demand for natural gas (CNG).

**Table 2.** Estimated annual growth of Brasil's GDP

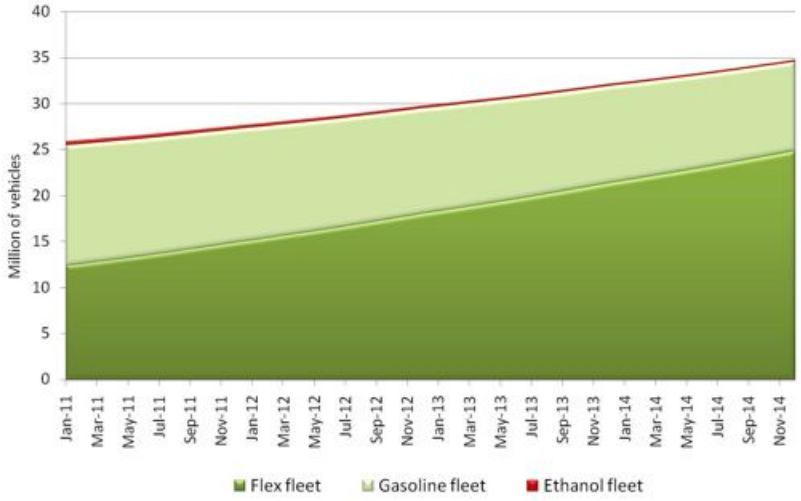
| Year | Projection of Brazilian GDP growth rate (%) |
|---|---|
| 2010 | 5.51 |
| 2011 | 4.39 |
| 2012 | 4.45 |
| 2013 | 4.60 |
| 2014 | 4.65 |

Source: Brazilian Central Bank, in April 09, 2010.

As a result of these assumptions, UNICA estimates that the Brazilian light vehicle fleet will exceed 34 million units by the end of 2014, of which more than 70% correspond to Flex Fuel vehicles, as see in Figure 4 in next page. And the domestic motorcycles fleet, estimated at about 20 million units by 2014, will continue to be predominantly fueled by gasoline (E25) since flex-fuel technology for motorcycles was only introduced in March 2009. See Figure 5 in next page.

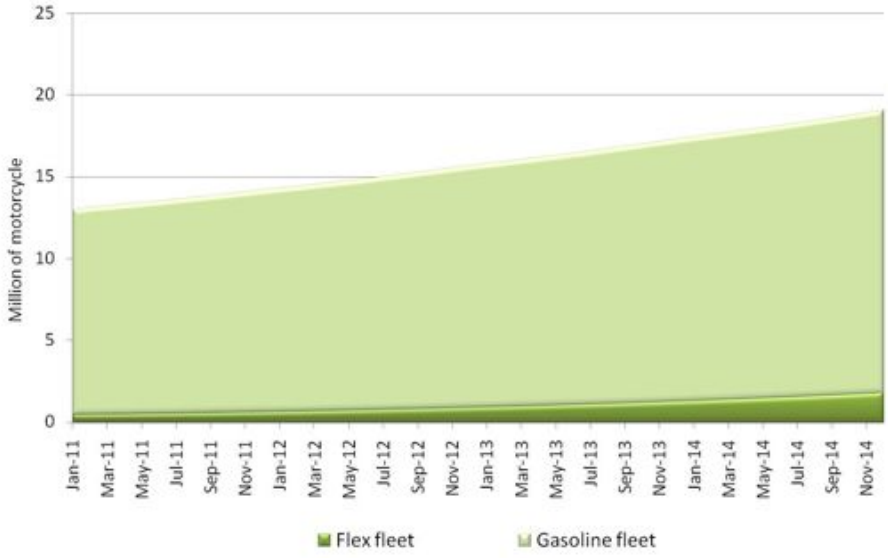
[1] Income elasticity of 1.3 is widely published in various academic research papers, including the Energy Research Company (EPE - agency under the Ministry of Mines and Energy) in the study "Prospects for Ethanol in Brazil", in estimating ethanol demand and supply in Brazil until 2017. Regarding the projected GDP growth, the source used was the Brazilian Central Bank (BCB), and the most recent forecast published by the institution was on April 9, 2010.

**Figure 4.** Estimated domestic vehicle fleet, by type of fuel.




Source: UNICA.

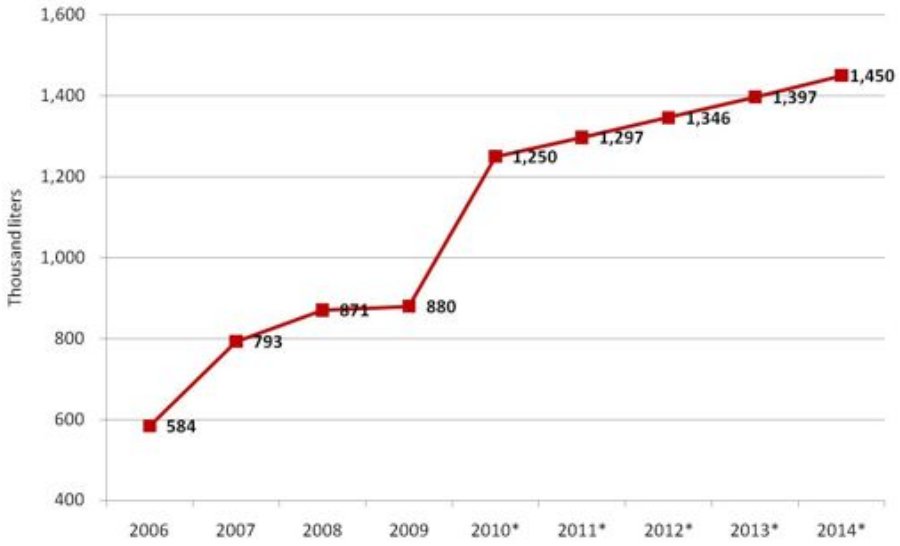
**Figure 5.** Estimated domestic motorcycle fleet, by type of fuel.




Source: UNICA.

In addition to the demand for fuel ethanol, it is important to highlight the growing demand of ethanol "for other purposes." In Brazil, ethanol has been used in the production of cosmetics, pharmaceuticals and chemicals. Recent announcements of a burgeoning biochemical industry in Brazil, suggests that he demand for these product may well grow considerably in the coming years, particularly in the production of the so-called "green plastics." Consequently, we've assumed that the recent growth rates in this industry would continue over the next five years.

**Figure 6.** Projected non-fuel ethanol demand in Brazil



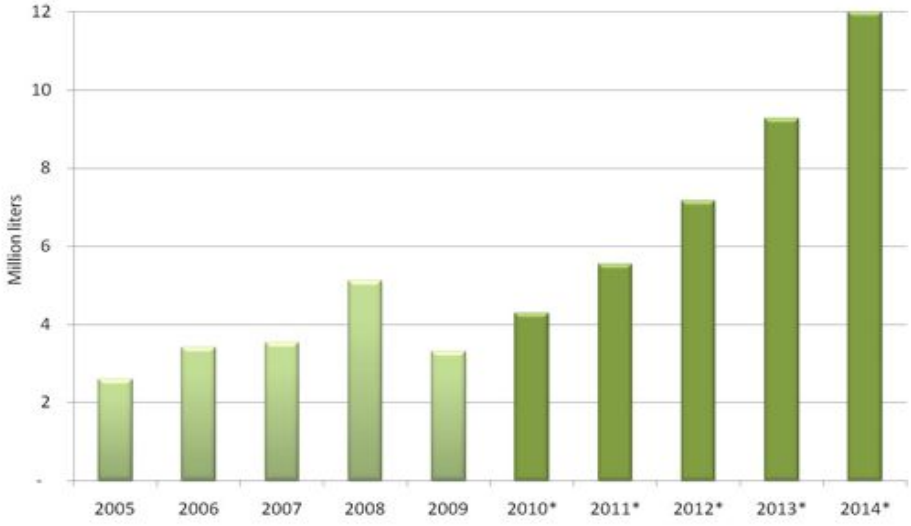

Source: UNICA. Notes: Data for 2006-09 is actual whereas 2010-14 is an estimated based on recent averages.

## C. Ethanol Export Logistics

Ethanol export statistics, released by the Brazilian Ministry of Development, Industry and Foreign Trade (MDIC), indicate that the maximum volume of ethanol exported by Brazil in a given month is about 600 million liters. In 2008, there were records of monthly ethanol exports from Brazil, largely in response to very high ethanol prices in the United States. That year, Brazil exported 621 million liters in August, 601 million liters in July, and 592 million liters in September 2008. According to industry observers, the country's ethanol logistics were operating at capacity then. Based on the simple arithmetic average of these values (605 million liters) annualized, we obtain the current export capacity of ethanol in Brazil is 7.2 billion liters per year.

Based on our estimates, Brazil could nearly double ethanol export capacity to 12 billion liters by 2014, if planned ethanol pipelines are build in the intervening period. See Figure 7 in next page. These pipelines would significantly reduce logistics bottlenecks, costs, and ensure greater efficiency in transport of ethanol from mills to seaport terminals.

**Figure 7.** Actual and Potential Ethanol Exports, in million liters




Source: UNICA; MDIC (for 2005 a 2009 data). Notes: 2005-09 actual observed values whereas 2010-14 are estimates based on scenario projections.

## D. Results

At last, a key determinant in the domestic demand for fuel ethanol is the establishment of choice patterns for the fuel to be consumed (near ethanol or gasoline) by owners of the growing (majority) of flex fuel vehicles. In a flex fuel car in Brazil, the consumer fuel choice decision is driven by the price relation between ethanol and gasoline. Based on this price relationship, as observed between 2007 to 2009 according to historical consumption data provided by the National Petroleum, Natural Gas and Biofuels Agency (ANP in Portuguese), and light vehicle fleet statistics, we can estimate that, on average, flex fuel vehicle owners have refuled with ethanol 70% of the time. See Table 3 for details. Consequently, for these projections, we considered a baseline scenario where 70% of flex-fuel vehicles use fuel ethanol during 2011-14. In addition, we modeled three other ethanol consumption scenarios for owners of flex fuel vehicles -- 100%, 60% and 50% ethanol-to-gasoline refueling.[2]

**Table 3**. Annual proportion of flex-fuel vehicles that use ethanol in Brazil and hydrous ethanol price to consumers (R$/liter) in the state of São Paulo.

| Year | % of flex fuel vehicles using ethanol | Retail hydrous ethanol price paid by consumers (annual average; real value) |
|---|---|---|
| 2007 | 67.63% | 1.422 (R$/liter) |
| 2008 | 69.83% | 1.364 (R$/liter) |
| 2009 | 70.44% | 1.362 (R$/liter) |

Source: UNICA and Center for Advanced Studies in Applied Economics (CEPEA), for price statistics. Notes: real prices, deflated by the National Extended Consumer Price Índex (IPCA), released by the Brazilian Institute of Geography and Statistics (IBGE).

[2] Scenario 1: 100% of flex-fuel vehicle owners use ethanol. Scenario 2: 70% of flex-fuel vehicle owners use ethanol. Scenario 3: 60% of flex-fuel vehicle owners use ethanol. Scenario 4: 50% of flex-fuel vehicle owners use ethanol.

The projected "surplus" available for export from Brazil was based on these four scenarios and from the estimated production disclosed in Item 1 of this study. See Table 4 below.

**Table 4.** UNICA's Projection of Brazilian Fuel Ethanol for Export, in billions of liters of ANHYDROUS ethanol

| | % of flex fuel vehicles using ethanol | Consumption scenarios | | | |
|---|---|---|---|---|---|
| | | 100% | 70% | 60% | 50% |
| **Variable** | **Year** | **Ethanol** | **Ethanol** | **Ethanol** | **Ethanol** |
| Fuel ethanol consumption | 2011 | 41.3 | 32.7 | 29.9 | 27.0 |
| | 2012 | 49.1 | 38.5 | 35.0 | 31.5 |
| | 2013 | 56.5 | 44.1 | 39.9 | 35.8 |
| | 2014 | 65.0 | 50.5 | 45.7 | 40.9 |
| Total ethanol consumption (fuel ethanol + other uses) | 2011 | 42.6 | 34.0 | 31.2 | 28.3 |
| | 2012 | 50.5 | 39.9 | 36.4 | 32.8 |
| | 2013 | 57.9 | 45.5 | 41.3 | 37.2 |
| | 2014 | 66.5 | 52.0 | 47.1 | 42.3 |
| Ethanol supply | 2011 | 34.1 | 34.1 | 34.1 | 34.1 |
| | 2012 | 39.3 | 39.3 | 39.3 | 39.3 |
| | 2013 | 45.1 | 45.1 | 45.1 | 45.1 |
| | 2014 | 53.5 | 53.5 | 53.5 | 53.5 |
| **Surplus for export** | **2011** | **(8.5)** | **0.1** | **3.0** | **5.8** |
| | **2012** | **(11.2)** | **(0.6)** | **3.0** | **6.5** |
| | **2013** | **(12.8)** | **(0.4)** | **3.7** | **7.8** |
| | **2014** | **(13.0)** | **1.5** | **6.3** | **11.2** |

Source: UNICA. Notes: We converted hydrous ethanol volumes in anhydrous using aforementioned conversion; 1 liter of anhydrous ethanol equals 1.0436 liters of hydrous ethanol. U.S. uses anhydrous, denatured ethanol for gasoline blendstock.