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ENVIRONMENTAL SCENARIOS FOR MANDATORY BIO-FUEL BLENDING TARGETS: AN APPLICATION OF INTUITIVE LOGICS

Marco Antonio Conejero
PhD Candidate – Post Graduate Business Administration Program
Universidade de São Paulo, Brazil

Marcos Fava Neves
Professor - Universidade de São Paulo, Ribeirão Preto, Brazil

Mairun Junqueira Alves Pinto
Masters level student at the Post Graduate Business Administration Program
Universidade de São Paulo, Ribeirão Preto, Brazil

RESUMO

Os cenários para as metas de adição obrigatória de biocombustíveis são uma parte importante do planejamento estratégico das cadeias produtivas de alimentos e bioenergia, sendo o seu desenho o objetivo desse artigo. Cada cenário conta uma história de como os vários elementos poderiam interagir sob certas condições. O método usado aqui tem como base as contribuições anteriores de Schoemaker (1995) e Schwartz (1991). Uma seqüência de seis passos é seguida: (a) identificar o foco de análise; (b) revisar as metas atuais de adição obrigatória; (c) identificar os direcionadores com base em uma analise macro-ambiental; (d) validar os direcionadores com especialistas; (e) priorizar tais forças motrizes em termos de importância perante incertezas, construindo-se uma matriz de correlação; (f) desenhar os cenários. Ao final, são propostos três cenários alternativos relacionados à adoção, por parte de países, até 2020, de metas de adição obrigatória de biocombustíveis, que poderão orientar os tomadores de decisão dos mesmos durante o planejamento de sistemas de produção.

Palavras-chave: Biocombustíves. Metas de adição obrigatória. Planejamento de cenários.

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ABSTRACT

Scenarios depicting targets concerning mandatory bio-fuel blending are critical to the strategic planning of food and bio-energy production chains and their design is the purpose of this paper. Each scenario tells a story about how various elements might interact under given conditions. The method herein utilized is primarily based on Schoemaker´s (1995) and Schwartz´s (1991) earlier proposals. A six step framework is followed: i) identify the focal issue; ii) summarize current mandatory blending targets; iii) identify the driving forces as of a macro-environmental analysis; iv) validate driving forces with specialists; v) rank such key forces by importance before uncertainties, building a correlation matrix; vi) design the scenarios. Finally, three alternative scenarios, relative to the adoption on behalf of countries, by the year 2020, of mandatory bio-fuel blending targets, are proposed which might guide these countries' decision makers when planning production systems.

Key-words: Bio-fuels. Mandatory blending targets. Scenario planning.

1 INTRODUCTION

The existence of a food and bioenergy global market depends on the development of transnational and sustainable agribusiness systems. In this process, strategic planning is core to the understanding of production systems and to enable the monitoring and adjustment of an increasingly dynamic international environment. Within this context, the construction and development of scenarios for mandatory bio-fuel blending targets, is critical to the future of food and bioenergy production chains. This is precisely the focal theme herein at hand.

Amongst the many tools a manager can resort to for strategic planning purposes, scenario planning comes to light given its ability to capture, in great detail, an extensive range of possibilities. By identifying basic trends and uncertainties, a manager can construct a series of scenarios that will help compensate for the most common mishaps concerning decision making – overconfidence and narrow mindedness (Schoemaker, 1995).

First, one ought to take a closer look at changes that are taking place in the macro-environment within the energy-centred world, regardless of corporate, governmental and social willingness.

In this analysis, a tool named "STEP analysis" is employed, commonly found when looking into strategic planning literature. Its purpose is to analyze major uncontrollable changes in productive systems so as to unveil opportunities and threats. These factors arise from the political-legal, economical-natural, social-cultural and technological environments (Neves, 2007a; Campomar and Ikeda, 2006; Jain, 2000; Johnson and Scholes, 1988).

Neves (2005) lists key factors which impact each dimension as depicted under the so-called PEST analysis framework. Amongst the most relevant political-legal factors, one should detail in special the: legal and political structure, political parties and their political orientation, legislative framework, institutions that legitimate, antitrust policies, political stability and government, labour legislation, regulation on foreign trade, environmental legislation, pressure groups (e.g., NGOs), tax policies, etc.

From an economical-natural standpoint, it is relevant to bear in mind, amongst others: the industry´s life cycle, interest rates, exchange rates, credit availability, investment levels, employment, energy availability and costs, economic growth, taxes, subsidies, concentration of suppliers, concentration of buyers, etc. (Neves, 2005). As far as the socio-cultural environment is concerned, some of the most important factors worth paying attention to include: demography, life style, social mobility, education levels, behavioural patterns, urbanization, family size, aging of the population, environmental and social concerns, etc. (Neves, 2005).

Finally, as to the technological environment, the main pondering factors comprise: the level of public and private investments in R&D, product life cycle, patents and intellectual property, input restrictions, concerns about eco-efficiency, pace and direction of technology transfers, etc (Neves, 2005).

Once having performed this analysis, the main trends and uncertainties to be considered when studying the world energy sector include:

- ✓ *In the political-legal environment:* the ratification of the Kyoto Protocol and its impacts on the patterns of energy consumption; restrictions on land (environmental impact) and water (for water recovery) usage; requirements regarding waste and residues; the imposition of emission reduction targets and the incremental adoption of bio-fuels, by countries.
- ✓ *In the economic and natural environment:* the ever increasing rise in oil prices; stronger competition between diverse renewable sources of energy; growth in sales of flex fuel and hybrid vehicles; the blending of biodiesel and ethanol with fossil fuels in order to reduce emissions; the opening of new markets for ethanol fuel (mainly the Asian market), new products (electricity) and the biomass competition; and finally, sustainable production chains.
- ✓ *In the socio cultural environment*: growth in the "green consumers" segment; affirmation of bio-fuel image as being that of a clean fuel; requirements for corporate social responsibility and governance; increased human health concerns; improved life quality quests; national produce defence; locally produced ethanol and biodiesel;

convenience and product variety drives; fair trade enhancement upon purchase decision-making; growth in the consumption of specialty products and traceability requirements.

- ✓ *In the technological environment:* improvement in the efficiency of flex-fuel and hybrid vehicles; hydrogen cell: fuel of the future; patenting of technology for the production of ethanol; technology of burning biomass and/or use of methane gas; major investments in the search for cellulose ethanol; integration of the ethanol plant and biodiesel; diversification of sources and energy production.

Therefore, as the objective of this paper, the construction of alternative scenarios for mandatory bio-fuel blending targets will contribute to the worldwide incorporation of various future possibilities in the formulation of objectives, guidelines, and strategies and to the ensuring of sustainable growth of country agribusiness systems.

2 LITERATURE REVIEW

According to Zylbersztajn and Neves (2000) and Batalha (2001), the agribusiness systems (chains) hold the following basic elements for descriptive analysis: the agents, the relations between them, the sectors (inputs, agriculture, industry, and distribution), the supporting organizations and the institutional environment. Ultimately, this is no more than a macro analysis of a product flow, from suppliers to final consumers.

Every country ought to seek designing and constructing a process for the strategic planning and management of productive chains. This, in turn, should prioritize the fields of coordination and institutional adequacy (laws), production and products, communications, distribution and logistics and human resources, so as to define projects to foment strategic thinking and to promote changes, as deemed necessary. This approach likewise holds true when it comes to matters concerning bio-fuels (Neves, 2007b).

The traditional planning tool is very valuable and indispensable; however it is incomplete given that variable elements are overseen. Scenario planning simplifies the avalanche of data into a limited number of possible states. Each scenario tells a story of how various elements might interact under certain conditions. Therefore scenario planning is a disciplined method for imagining possible futures which companies have applied to a great range of issues (Schoemaker, 1995). Scenario planning is a consolidated tool that assists strategic planning. Scenario planning helps all actors involved to develop and clarify practical choices, policies and alternative actions that might appear to be the necessary consequences of the scenario (Coates, 2000; Lambin, 2000).

Scenarios are descriptions of the possible futures concerning an issue. Their purpose is to help analysts and decision makers understand the assortment of events that might take place and their possible impacts. The scenario itself is not a forecast, although it may contain or be based on forecasts. Rather, a set of scenarios, typically three or four in number, is intended to stimulate thought concerning future events, the relationships between them and the uncertainties surrounding them (Obrien, 2004; Schwartz, 1991; Chermack, 2005; Blanning and Reinig, 1998; Heijden, 1994).

Scenario planning attempts to capture the richness and range of possibilities, stimulating decision makers to consider changes they would otherwise ignore. At the same time, it organizes these possibilities into narratives that are easier to grasp and use than large volumes of data. Organizations facing the following conditions will, in special, benefit from scenario planning (Schoemaker, 1995):

- ✓ Uncertainty is high as compared to management´s ability to predict or adjust;
- ✓ Too many costly surprises have occurred in the past;
- ✓ The company does not perceive or generate new opportunities;
- ✓ The quality of strategic thinking is low (overly standardized or bureaucratic);
- ✓ The industry has experienced or is about to be exposed to significant change;
- ✓ The company seeks a common language and framework that will not stifle diversity;

- ✓ There are strong differences of opinion and multiple merit worthy opinions;
- ✓ Competitors are using scenario planning.

Jain (2000) presents some characteristics of the use of scenarios:

- ✓ They are primarily qualitative in nature;
- ✓ They are based on the belief that the future cannot be measured or even controlled and that the time periods subsequent to an event, are uncertain;
- ✓ They are always taken into account in a collective manner, setting forth the notion of alternative futures without any given methodological unity when looked upon from a standalone perspective;
- ✓ They are tools that support comprehension, which basically position the decision maker within a panorama of causality, whereby the rejection of a given hypothesis does not imply in the acceptance of another and therefore offers no determiners but rather possibilities, consequences and contingencies;
- ✓ They group essential factors that must be taken into consideration, analyzing their inter-relationships and their possibilities.

Nowadays scenario planning needn´t be based on subjective data given that there are methods establishing the steps required for the envisioning of future scenarios. The method utilized herein is mostly based on that proposed by Schoemaker (1995) and Schwartz (1991), namely:

	SCHOEMAKER (1995)	SCHWARTZ (1991)
Step 1	**Define Scope** -Set the time frame and the scope of analysis (products, markets, geographic areas and technologies).	**Identify Focal Issue or Decision** - Sound scenario development approaches start "from the inside out" rather than "from the outside in"; -Begin with a specific decision or issue, then build towards the outermost environment.
Step 2	**Identify Major Stakeholders** -Interview customers, suppliers, competitors, employees, shareholders, and government as to the future.	**Local Environment Key Forces** -List key factors influencing success or failure of a given decision; -Facts concerning customers, suppliers, competitors, etc.

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	SCHOEMAKER (1995)	SCHWARTZ (1991)
Step 3	**Identify Basic Trends** -Political, economical, societal, technological, legal and industry trends; -List all trends on a chart to identify impacts on strategy (positive, negative or uncertain).	**Driving Forces** -List macro-environment driving forces influencing the previously identified key factors; -Prepare a checklist of social, economic, political, environmental and technological forces.
Step 4	**Identify Key Uncertainties** -Which events, whose outcomes are uncertain, will significantly impact issues of your concern? ; -Identify relationships amongst such uncertainties.	**Rank by Importance and Uncertainty** -The degree of importance concerning the successful outcome of the focal issue or decision identified. -The degree of uncertainty surrounding those factors and trends; -The results of this ranking exercise are, in effect, the axes along which eventual scenarios will differ.
Step 5	**Construct Initial Scenario Themes** -Given trend and uncertainty identification, the main ingredients for scenario construction flourish; -Identify extreme worlds by putting all positive elements on one side and all negative ones at another.	**Selecting Scenario Logics** -The logic of a given scenario will be characterized by its location in the matrix depicting the most significant scenario drivers.
Step 6	**Check for Consistency and Plausibility** -Simple worlds might present internal inconsistencies or lack a compelling story telling line.	**Fleshing Out the Scenarios** -Each key factor and trend should receive some attention under every given scenario; -Sometimes it´s quite obvious on which side of an uncertainty which given scenario ought to be placed, whilst at others this is not promptly identified.
Step 7	**Develop Learning Scenarios** - Identify themes that are strategically relevant and then organize the possible outcomes and trends around them; - These scenarios serve as tools for research and study rather than for decision making purposes.	**Implications** - Return to the focal issue or decision identified in step one so as to rehearse the future.
Step 8	**Identify Research Needs** -Undertake further research so as to flesh out your understanding of uncertainties and trends.	**Selection of Leading Indicators and Signposts** -Dedicate time and envisioning to identify some indicators to monitor scenarios in an ongoing manner.
Step 9	**Develop Quantitative Models** -Reexamine scenario internal consistency and evaluate whether certain interactions may be formalized using a quantitative model; -Quantify the consequences of various scenarios.	
Step 10	**Evolve Towards Decision Scenarios** -Convergence to scenarios that will eventually be utilized to test strategies and generate new ideas.	

Chart 1: Main Scenario Author Revision Summary

Source: Prepared by the authors.

This method is limited to following a sequence of steps which may be followed by other researchers. One might classify it as being intuitive logics. This type of method was first described by Pierre Wack (1985) and then used by the Shell group. Later, Peter Schwartz (1991) put it into practice through Stanford Research Institute consulting firms, namely the SRI International and Global Business Network (GBN) (Boaventura and Fischmann, 2007).

This method also allows for the creation of first-generation or environmental scenarios whose purpose is to venture towards the understanding of environmental variables and their basic uncertainties (Wack, 1985).

Despite its application as a strategic management tool, scenarios can also present problems. Schoemaker (1995) alerts as to participant biases at the time of scenario construction given they might lead to unrealistic interpretations of present and future environments.

3 METHODOLOGY

Methodological procedures were so defined: (1) review of the scenario planning method; (2) review of agribusiness systems literature as related to the production of bio-fuels and country policies concerning mandatory blending targets; (3) in-depth interviews with experts from the industry, government, universities and research centres, plus surrounding organizations; and (4) the issuance of a structured questionnaire to validate key variables so as to design mandatory blending targets scenarios.

Keeping this in mind, we thus propose the following method:

- ✓ Step 1 – Identify the Focal Issue: Main Countries Mandatory Blending Targets: When developing scenarios, it´s a good idea to begin with a specific issue and thereafter take the environment into account. Here, the main scope is to analyze increases in and the dissemination of, mandatory blending targets. What will decision makers, at each country, think in terms of bio-fuels, in the near future? What are the decisions pertaining the issue mandatory blending targets, that will have to be taken? What is the long-term influence of such decisions on the country´s competitiveness?

- ✓ Step 2 – Summarize Current Main Countries Mandatory Blending Targets: The second step is to review the present and expected mandatory blending targets of each key country. In this work, it was found that the expected and existing announced targets concerning the addition of bio-fuels are, in general, extended, that is, valid till the year 2020. That is why scenarios herein proposed were conceived for the year 2020. Likewise, this data will be relevant for the verifying of the expected size of the bio-fuels market, in the near future. By adding on potential market simulations - given widespread adoption by countries of mandatory blending targets - one might figure out the level of production required for compliance with hypothetical bio-fuel policies, at several countries.
- ✓ *Step 3 – Identify Key or Driving Forces:* The third step involves listing key forces based on the macro-environment that influence mandatory blending targets. This is the most research-intensive step in the process. In this sense, the research has covered markets (oil, bio-fuels, feedstocks), new technologies (flex-fuel cars, hybrid cars, hydrogen cell, hydrolysis into cellulose ethanol and new agricultural varieties), political factors (governmental restrictions and incentives), economic forces (bio-fuels productivity, production costs and processing capacity) plus sustainability forces (social and environmental improvements).
- ✓ Step 4 – Key Force Validation with Experts: Once key forces have been defined, they ought to be submitted to experts for validation and suggestion purposes. This approach ensures both safety and strength to the analytical process itself. Forces and respective descriptions are forwarded by e-mail for approval, in compliance with a pre-qualified network of experts. Final key forces thus include consolidated answers and proposed modifications whilst excluding divergent opinions. In this study, the referred network derives from the annual International PENSA Conference on Agri-Food and Bioenergy Chain/Networks, organized by the University of Sao Paulo´s Agribusiness Intelligence Centre, Brazil (PENSA). This conference brings together professors and researchers from around the world that are engaged with bio-fuel issues. Experts are originally from Canada, the United States, Argentina, Brazil, Germany, France, The Netherlands, South Africa, India, China, Japan and Indonesia.

- ✓ Step 5 – Rank by Importance vs. Uncertainty and the Correlation Matrix: Next, key factors are ranked based on two criteria: first, the degree of importance to the success of the focal issue (mandatory blending targets); second, the degree of uncertainty surrounding such factors and trends. The idea is to compile an opinion map (perceptual map) based on the opinion of the experts in as much as identifying the factors that are most important and most uncertain, is concerned. Their opinions do not constitute a random sample; therefore, they are not susceptible to statistical inference. The end result of this task is a set of key variables for this study, which effectively are the environment variables that pose greater standing in terms of influencing the focal issue (mandatory blending targets) despite their uncertainty and the fact that are capable of generating contrast scenarios, based on their eventually diverted, final resultant state.
- ✓ Step 6 – Designing key country mandatory blending targets scenarios: The results of the ranking exercise are effectively, the axes, and between these, eventual scenarios will differ. Determining these axes is one of the most important steps in the entire scenario-generating process. The goal is to end up with just a few scenarios (pessimistic, optimistic and realistic) that must be well understood by decision makers so as to truly be, of use.

These fundamental differences—or "scenario drivers"—must likewise be no more than a handful so as to avoid the triggering of an assortment of scenarios surrounding each and every possible uncertainty. Many things can happen, but only a few scenarios ought to be designed efficiently, in a detailed manner.

4 DATA PRESENTATION AND ANALYSIS

4.1 STEP ANALYSIS

To develop multiple scenarios concerning an issue that involves the future of the world's energy and the dealing with an industry known for its high risks and long-term investment projects, various macro-environmental changes call for analysis. Chart 2 depicts environmental changes per opportunity or threat perception.

	POLITICAL – LEGAL	ECONOMICAL - NATURAL	SOCIAL-CULTURAL	TECHNOLOGICAL
OPPORTUNITIES	▪ Addition of ethanol to truck engines; ▪ New emission-reduction targets and growth of the carbon credit markets; ▪ General tax incentives for bio-fuels production; ▪ Development and internalization of bio-fuels market in developing countries, with the advance of new projects (bio-fuels and feedstock production) at degraded areas; ▪ Addition of ethanol in different countries, replacement of MTBE used in gasoline to meet the environmental agenda; ▪ Addition of biodiesel in different countries, the decreased level of sulphur emissions, and greater lubricity to the engine; ▪ Alliance of developing countries with developed countries to obtain preference for imports and not compete with food production; ▪ Prohibition to burn sugarcane, generating both more energy to crush and ethanol facilities	▪ Growth in population and increase of wealth (China and India), increasing consumption; ▪ Growth in the consumption of sugar (products/foods that use sugar); ▪ High prices of oil; ▪ Growth in flex-fuel vehicle fleets; - Export of technologies and bio-fuel facilities from actual producers' countries to new ones; ▪ New and high flows of foreign direct investments in bio-fuel industries; ▪ Loss of production in some countries' generating opportunities to others; ▪ Emergence of new producers (Caribbean and Asia); ▪ Focus in core competence (bio-fuels industry), independent supply of feedstock with better income distribution; ▪ Rotation of crops - food and energy, causing an increase of food production in the areas of renewal energy crops; ▪ Land availability for expansion of the bio-fuels sector in developing countries; ▪ Positive energetic and carbon balances for all bio-fuels sources; ▪ Vertical integration from the bio-fuels facilities to the fuels' distribution; ▪ Lack of credit/funding lines with easy access; ▪ Small environmental services markets.	▪ More awareness of global warming; ▪ Migration of people to cities (eg.: China) demanding processed food and high volumes of fuels; ▪ Image of the renewable and clean fuel; ▪ Defense of sustainable bio-fuel productive chains; ▪ Acceptance of GMO's; ▪ Movements of Organics/ FairTrade/ Nutraceutics/ Cosmetics; ▪ Inclusion of smallholders; ▪ Generation of green jobs and income	▪ New technologies enhancing flex-fuel vehicle efficiency; ▪ Mechanization of the harvest; ▪ Generation or expansion of cellulosic ethanol use (biobutanol, hydrolysis); ▪ Genetic modification of energy crops for resistance to dry weather and diseases; ▪ Use of satellites and precision agriculture (GPS); ▪ Research in fertilizers (varieties that use less fertilizer); ▪ Use of biofertilizers from by-products; ▪ Integration of biodiesel and ethanol facilities; ▪ Focus on energy efficiency (hybrid cars, reducing the weight of cars) allowing the use of renewable energy (ethanol, biodiesel, biomass); ▪ Technological gains in sugarcane and palm competitor efficiency (corn, beet, and rapeseed).

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	POLITICAL – LEGAL	ECONOMICAL - NATURAL	SOCIAL-CULTURAL	TECHNOLOGICAL
THREATS	▪ Social-environmental barriers to bio-fuel imports; ▪ Lack of international law governing bio-fuel standardization for export (in the world market); ▪ Stricter work and environmental laws for bio-fuel production; ▪ The oil companies, the local producers, and the ethanol lobbies against imported ethanol; ▪ Slow and tendentious legal environment (contractual hold-up problems, delays in justice, bureaucracy, etc.); ▪ Lack of regulatory stocks of bio-fuels in countries (to avoid fluctuation of commodity prices); ▪ Discontinuity of the tax incentive programs over the long term (breaks).	▪ Growth in the hybrid vehicle fleets; ▪ Lack of machines and equipment for expansion of industrial capacities; ▪ High agricultural commodity (feedstock) prices; ▪ More powerful diseases or pests; ▪ Climate change bringing reduction in the available lands; ▪ Lack of ag inputs (fertilizers mainly); ▪ Concentration of the bio-fuel sales in a few major markets (US, EU) or companies (e.g., BP, Exxon, Chevron, Shell, Petrobras); ▪ Inflationary process in food prices; ▪ Competition of bio-fuel industries with alternative distribution channels by the right of by-products (agricultural residues).	▪ High supply and use of public transportation; ▪ High migration flows of people to developed countries; ▪ Image of jobs generated by the energetic crops employed in the harvest in developing countries (sugarcane, palm); ▪ Image of land occupation generating competition with food; ▪ Image of the "monoculture"; ▪ Growth of NGOs, with destructive purposes (bioterrorism); ▪ Hard requirement of social-environmental certification; ▪ High cost of certification; ▪ Mechanization vs. unemployment in agriculture; ▪ Number of different seals.	▪ Substitution products for bio-fuels; ▪ New technologies generating more competitive energy (hydrogen); ▪ Growth in the fleet of natural gas or hybrid vehicles; ▪ Deficient infrastructure for distribution of agricultural production from new frontiers; ▪ Low investments on R&D in developing coutries.

Chart 2: Bio-fuels AGSs (Agribusiness Systems) Opportunities and Threats Summary

Source: Prepared by the authors.

4.2 MANDATORY BLENDING TARGETS

4.2.1 Ethanol Blending Targets

According to Datagro (2008), world ethanol production has increased at an average 12.2% per annum rate between the years 2000 and 2008. In 2007, the world ethanol production for bio-fuel reached 49.5 billion l, accounting for 4.3% of the world's gasoline consumption (1.117 trillion l). Forecasts state that by 2020, fuel consumption is expected to further increase approximately 40% which effectively means that there is plenty of room for the ethanol market to expand.

Most recently, the international market has become receptive towards anhydrous ethanol in particular, given governmental policies in relation to the addition of this bio-fuel to gasoline. Some countries have already approved mandatory blending targets, whilst others have authorized the blending process.

Table 1 provides a summary of policies as implemented by some countries. On one hand, this table poses to illustrate the production capacity and/or the real production per country; on the other, it portrays the potential demand mandatory blending generates.

We are not herein concerned with data accuracy, but rather with expected global trends. Considering almost every country, a gap is noted between the potential demand generated by mandatory blending and the local production capacity. Therefore, there is room for the strengthening of the international ethanol market.

Table 1: Potential Demand for Ethanol

Country	Gasoline Consumption 2006/07 (billion l)	% of blend up to 2020	Potential Demand up to 2020 (billion l)	Production/ Capacity 2006/07 (billion l)
US	530	RFS requires 7.5 billion gallons (BG) by 2012 (28.5 billion l). The new energy bill requires 36 billion gallons (BG) by 2022 (136.2 billion l).	136	Production: 26.5 Installed capacity: 34 (126 facilities) In projects: 66 (100 facilities)

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Country	Gasoline Consumption 2006/07 (billion l)	% of blend up to 2020	Potential Demand up to 2020 (billion l)	Production/ Capacity 2006/07 (billion l)
EU	148	5.75% (2010) 10% (2020)	8.51	Production: 2.3 Installed capacity: 3.5 (38 facilities) In projects: 3.8 (30 facilities)
China	54	10% Expected 15% (2010)	5.4	Production: 1.2 Installed capacity: 1.5
Japan	60	3% authorized Expected 20% in 2030	1.8	Production: 0.1
Canada	39	5% (2010)	1.95	Production: 0.7 Installed capacity: 1.6
United Kingdom	26	5% (2010)	1.3	Production: 0.03
Australia	20	10%	2.0	Production: 0.075 Capacity: 0.605
Brazil	25.2 (2008)	20–25%	6.3 (only with mandatory blend targets) 13.3 (hydrated ethanol for flex fuel cars)	Production: 20.5 (336 facilities) Projects: 15 (76 facilities).
South Africa	11.3	8%	0.9	Production: 0.12
India	13.6	5% 10% (2012)	0.68	Production: 0.25 Installed capacity: 3.2
Thailand	7.2	10%	0.7	Production: 0.1 Capacity: 0.2
Argentina	5	5% (2010)	0.25	Production: 0.2 Capacity: 0.25
Philippines	5.1	5% (2009) 10% (2011)	0.26	Production: 0.08
TOTAL	**943.2**		**178,7**	**52,2+92,2 = 144,3**

Source: Prepared by the authors based on The President´s Economic Report (2008), Coyle (2007), RFA (2008), EIA/DOE (2007), EBIO (2007), USDA/FAS (2006), USDA/FAS (2007), UK Department of Transport (2007), UKTRADEINFO (2008), IEA (2005), Greenfuels (2007), RIRDC (2007), Datagro (2008), UNICA (2007), ANP (2009), SAGPYA/MECON (2007), Mathews e Goldztein (2007).

As depicted in the previous table, the demand for ethanol will increase to approximately 179 billion l, given current targets. However, even if one adds the existing installed capacity to that currently being built, production would only rise to 145 billion l. This clarifies doubts concerning the existence of room for market growth.

4.2.2 Biodiesel Blending Targets

Basically there is no international market for biodiesel and the volumes produced are considerably lower than those expressed by the ethanol industry. Nevertheless, in terms of future perspectives, the biodiesel business is expected to grow more than that of the ethanol industry since the diesel share in terms of the world's fuel matrix, is greater than that of gasoline.

Therefore, one might state that there is a place of great relevance where the international biodiesel market might flourish. A major setback for production plans and mandatory blending targets is however the international vegetable oil market which is driven by population growth, economic prosperity and the so-called food-feed-fuel competition. This impacts record prices for these oils at the main international stock exchange markets. Table 2 provides a summary of policies taken to effect by selected countries.

Table 2: Potential Demand for Biodiesel

Country	Diesel Consumption (billion l)	% of blend	Potential Demand (billion l)	Production/ Capacity (billion l) 2006/2007
European Union	354	2% interim target 5.75% (2010) Expected 10% in 2020.	35.4	Production: 6.5 Capacity: 18
USA	220	28.5 (2012) 136.8 (2022)	136.8	Production: 1.3 Capacity: 1.9 In projects: 4.5
China	105	Expected 15% (2020).	13.8	Production: 0.018 In projects: 6.5
Brazil	39	3% (2008) 5% (2012)	1.95	Production:0.7 Capacity: 1.62 In projects: 1.9
India	37.8	5% 10% (2012).	3.7	Production: 0.8
Canada	26	2% (2010)	0.52	Production: 0.1
Indonesia	26	5%	0.65	Production: 0.7 In projects: 5.9
United Kingdom	24	3.75% (2009) 5% (2010)	1.2	Production: 0.1
Argentina	14	5% (2010)	0.7	Production: 0.2 Capacity: 1 In projects: 4

Continues

Continuation

Country	Diesel Consumption (billion l)	% of blend	Potential Demand (billion l)	Production/ Capacity (billion l) 2006/2007
Thailand	21	5% Expected 10% (2012)	1.06	Production: 0.15
Australia	14.5	2% (2008) 5% (2013)	0.05	Production: 0.1 Capacity: 0.5
Malaysia	7.5	5% (2008)	0.375	Production:0.25 In projects: 7,5
Philippines	7	5% (2008).	0.35	Production: 0.16
South Africa	5	2%	0.1	Production: 0.03
Total	900.8		196.7	25.3 + 30.3 = 55.6

Source: Prepared by authors based on EBB (2007), NBB (2007), F.O. Licht's (2007), EIA/DOE (2007), Coyle (2007), USDA/FAS (2007), ANP (2007), IEA (2005), Nacarajan (2008), MPOC (2006), BAA (2007), UKTRADEINFO (2008), RIRDC (2007), UK Department of Transport (2007), Mathews and Goldztein (2007), Molina (2007) and SAGPYA/MECON (2007).

According to the previous table, current blending targets will increase the demand to approximately 197 billion l. However, much like the ethanol market, the world's installed capacity of biodiesel does not meet such a level of demand. All existing production facilities in addition to those being built would only produce at most 56 billion l of biodiesel.

4.3 KEY FORCES

Following the STEP analysis approach, major key forces are:

OIL PRICES: encompass current and future oil prices and oil reserve availability.

Between 1998 and 2007, the price of a barrel of oil increased over 500% (NYMEX, 2007). On February 19, 2008 the barrel peaked at US$ 100.00 for the first time in history. Nowadays the price of an oil barrel varies between US$ 50.00 and US$ 80.00. Pressure on prices mostly derives from a complete reserve depletion perspective. Some studies indicate that the reserves might dry up in approximately 40 years (British Petroleum, 2006).

Despite new reserve discoveries, these will not cope with long-term growth in demands for energy. According to IEA (2006), based on current global energy trends, this will increase 53% by 2030. In addition to high prices and threats concerning scarcity, another risk factor lies in the fact that the largest oil reserves are located at unstable regions. Major oil suppliers still dwell in the Middle East that accounts for 62% of the world's reserves, followed by countries in Europe and other regions of the Asian continent (BP, 2006).

From this standpoint, will bio-fuels be at all feasible? According to UNICA (2007) projections, should oil prices surpass US$ 80.00 per barrel, biodiesel then becomes feasible. For ethanol, the scenario is much brighter: oil prices just over US$ 40.00 a barrel make Brazilian sugarcane-based ethanol viable.

TRANSPORTATION DEPENDENCY ON OIL: includes transportation sector energy demand, transportation fossil fuels consumption as compared to other sources and the participation of the transportation sector in the world's energy matrix.

According to WBCSD (2004) the transportation sector share on oil demand is expected to increase (from 56% to 62%) within the period (2.1% a year) given 60% raises in consumption. Therefore, fossil fuels ought to continue being at the core of energy sources for transportation purposes despite advances in renewable and less carbon-intense fuels (LPG, ethanol, biodiesel and hydrogen). Changing this scenario calls for investments in R&D (Research and Development) as well as in the image of bio-fuels as a clean, safe and low cost source of energy.

In North America, gasoline represents over 50% of the total energy demand for transportation, whilst diesel accounts for approximately 20%. Western Europe presents a different consumption pattern as both diesel and gasoline are responsible for some 37.5% of the sector´s demand. Gasoline is used to a greater extent in Asia (45%). Therefore, North America and Asia are the most promising markets for Brazil´s ethanol (WBCSD, 2002).

In as much as the share of road transportation categories in fuel consumption are concerned, light vehicles and trucks represented over 60% of the demand in 2002. However, light personal vehicles only accounted for 50%. Due to high per capita incomes, developed countries hold the largest light duty vehicles fleets (WBCSD, 2004). Improvements in per capita income usually imply in expansion of vehicle fleets.

GOVERNMENTAL BIO-FUEL INCENTIVES: as relative to subsidies and tax incentives.

Much of the world's production of bio-fuels calls for some kind of incentive such as subsidies or tax exemptions to ensure prices are economically viable as compared to fossil sources.

In this sense, OECD data (2005) (average 2002-2004) portrays major countries supporting internal producers (in terms of % of the growers' gross revenues that derives from governmental support), namely: Japan (58%), the European Union (34%), Canada (22%), Mexico (21%) and the US (17%). In Brazil, only 3% of the producers' revenues come from federal support in the form of subsidized interest rates that result from agricultural debt renegotiations.

Tax reductions spruce in varied modes. These may be applied to the production and trade of bio-fuels, flex-fuel vehicles and also in engine conversion services that allow for the use of ethanol, biodiesel or blended fuels. Some governments also offer special financing possibilities to projects engaged with bio-fuels.

The United States presents a combination of federal, state and local subsidies that cover each transaction of the entire productive chain (industry, storage facilities, distribution centres and final ethanol consumers) and also the purchase of clean vehicles.

In 2003, the European Commission authorized member states to grant tax exemptions for ethanol and biodiesel producers (Steenblik, 2007). The Brazilian government offers tax deductions for biodiesel companies that buy a minimum percentage (50%) of their feedstock from small growers, who produce a couple of specific oilseeds (Jatropha curca, castor oil and palm) in the northern and north-eastern regions of Brazil (Probiodiesel, 2007).

Some countries also reduce export tariffs for bio-fuels in an attempt to stimulate internal production. Argentina, for instance, has different tariffs for products of the soybean value chain. While soybean meal and oil exports are taxed 24.5% of total revenues, exports of biodiesel are taxed 5% (Mathews and Goldztein, 2007). Given this policy, the government can stimulate production without necessarily depending on the internal demand.

GOVERNMENTAL BIO-FUEL RESTRICTIONS: relates to barriers (*ad valorem* and specific import taxes, import quotas, fuel standardization and certifications).

Whilst governmental incentives seek to encourage the domestic production of bio-fuels, there are some restrictions protecting local growers from foreign competition. These restrictions may include fuel standardization, requirements for specific productive skills, social and environmental certifications, import quotas and import tariffs, amongst others.

Import tariffs are the most relevant restriction alternative, such as *ad valorem* and specific tariffs, for instance. As per IEA´s (2004b) data, Australia, a strong producer of sugarcane-based ethanol, has a specific import tariff of US$ 0.24/l on ethanol. The European Union taxes imports on a US$ 0.10/l basis (forthcoming environmental certification requirements), whilst Canadian importers pay US$ 0.07/l, the same value per litre as that practiced in Brazil. In the US, the world's largest ethanol market, the import tariff is US$ 0.54 per gallon – mandate expiring in 2010; however, it's expected to be further extended.

Nevertheless, tariffs are not limited to final products. Some countries also apply import tariffs to raw materials employed in the production of bio-fuels.

CLEAN VEHICLE ADOPTION: comprises the size of the vehicle fleet and its growth rate, adoption rate of hybrid cars vs. flex-fuel cars by main countries, the perspective of introducing cars utilizing hydrogen fuel cells, the growth in the number of light-duty vehicles (LDVs) and the number of cars owned by inhabitants.

Developed countries present the largest portion of the world's fleet; however, it is at developing countries that the situation calls for greater attention. Goldman Sachs' forecast indicates that by 2040, China and India will respectively portray 29 and 21 cars for every hundred inhabitants, totalling over 700 million cars.

Currently, the world's largest fleet is to be found in the US, where there are approximately 250 million vehicles utilizing American roads (RFA, 2008). The production of E85 (85% ethanol and 15% gasoline) cars, grows at a faster rate than that of other vehicles. In 2005 alone, E85 flex productions increased 16%

as compared to a 5% growth in the production of vehicles that exclusively run on fossil fuels (OICA, 2007). According to the Renewable Fuels Association (RFA, 2008), the US fleet already accounts for 7 million E85 flex vehicles. The most relevant barrier to the wide spreading of this technology throughout the country however, is the low number of fuel stations that offer the product. Less than 2% of the 170 thousand American fuel stations offer E85 pumps.

Flex-fuel cars were adopted in Brazil since their very launch in 2003. This new technology promoted a major change in consumer behaviour due to the fact that it minimizes risks posed by exclusively ethanol fuelled cars, such as the shortage of fuel and high prices during mid-crops. The impact of flex-fuel vehicles (FFVs) in car sales was intense and rampant. In the market debut year, FFVs' share in total light-duty vehicle sales topped 6.8%. In 2009, FFVs accounted for over 90% of total sales and already represent 40% of Brazil's light vehicle fleet. Projections claim that by 2015, the Brazilian fleet will comprise 30 million vehicles, of which 19 million are expected to be of the FFV type (ANFAVEA, 2010, UNICA, 2010).

This context results from both convenience and products being effectively made available to end consumers. In Brazil, all 35 thousand fuel stations are supplied with ethanol and the bio-fuel produced as of sugarcane has already substituted an enormous volume of gasoline. Currently, ethanol represents 54.5% of the local fuel market (ANP, 2010).

In the long term, plug-in hybrids, bio-fuels from cellulosic materials and hydrogen fuel cells are alternatives of interest but all require major advances in R&D to reduce production costs.

FEEDSTOCK PRODUCTION CAPACITY: comprises global bio-fuel productivity and production costs, the level of irrigation usage, available land vs. occupied land, current and future feedstock prices (sugarcane, grains and vegetable oils) as a consequence of food consumption, food and fuel competition.

In several countries, the production of ethanol and biodiesel is still highly dependent on subsidies for market survival purposes. Most of the time, high costs are associated with less than ideal level yields – in relation to that of substitutes—and with the scarce use of by-products (agricultural residues).

There are considerable differences in ethanol productivity when one takes into account the type of raw material utilized and where production takes place. Comparatively, Brazil is by far the country that presents the highest yield figures. The country produces an average 6,800 l/ha of sugarcane-based ethanol, whilst the EU produces 5,400 l/ha of sugar-beet ethanol and only 2,400 l/ha of wheat ethanol; India 5,200 l/ha (also as of sugarcane); the U.S. 3,100 l/ha (as of corn); and Thailand 3,100 l/ha (as of cassava). This fact ensures Brazil produces the cheapest ethanol in the world at a price of US$ 0.22/l. In the U.S., the bio-fuel manufactured as of corn costs US$ 0.30/l and in Europe ethanol is produced at US$ 0.45/l from grains and US$ 0.53/l from sugar beet, respectively (F.O. Licht's, 2007).

Investments in R&D to improve the agricultural production (irrigation methods, genetic improvement in seeds, management skills, improvement in fertilizers and others) are strategic actions which consolidate bio-fuels as an alternative source of energy. On the other hand, there is also a limitation of agricultural land made available for bio-fuels and a trade-off between food and bio-fuel production. Developed countries present a disadvantage because most of their agricultural lands have already been explored and thus, such a competition tends to be inevitable. FAO's (2007) data indicates that only a handful of countries still offer land for agricultural conversion. Brazil tops the rank in terms of available land estimated at 394 million ha of which only 66 million is being utilized. Next comes the US, with 81 million ha of unused land, followed by Russia (88 million), the EU (61 million), China (42 million), Australia (37 million), Canada (30 million) and Argentina (44 million ha). India, despite its extensive territory, has all 169 million ha worth of land duly occupied.

BIO-FUEL PRODUCTION CAPACITY: includes the construction of new facilities, increase in ethanol productivity with hydrolysis (cellulosic ethanol) and by-product usage levels.

In recent years, the construction of bio-fuel facilities has expanded intensively. The underlying reason for this growth in many countries is the rise of domestic market demands given blending targets and also, potential export perspectives. In-depth analysis undertaken by the Inter-American Development Bank (Rothkopf, 2007) points that in 2005, investments in bio energy (ethanol, biodiesel, biomass for electricity and some others) reached US$ 2.66 billion, and only one year later, in 2006, this amount was 7.9 times greater, peaking at US$ 21 billion.

One might also use the hydrolysis process to obtain ethanol. Hydrolysis enables ethanol to be produced as of whatever possible source of cellulose. In terms of corn and sugarcane, the hydrolysis process might arise from the use of residues such as leaves, straw and bagasse (from sugarcane). Today, some by-products are under-used or even discarded. This industrial process is, however, still in its early stage of development.

The mentioned technology would increase ethanol production worldwide, utilizing the very same agricultural lands. In 2005, the production of conventional ethanol in Brazil was 85 l/t of sugarcane or 6,000 l/ha. In 2015, the conventional production will reach some 100 l/t, or 8,200 l/ha and production by hydrolysis, 14 l/t or 1,100 l/ha. In 2025, conventional processes are expected to produce 109 l/t or 10,400 l/ha whilst via hydrolysis, an additional 3,500 l/ha (Leal, 2006).

According to the National Renewable Energy Laboratory (NREL, 2006), cellulosic ethanol will be the solution to increase yield and support production so as to meet the global demand for fuel. Some countries like Brazil have already begun using residues from the fields as a source of energy (bagasse and leaves) and of bio-fertilizers (vinasse). This results in an increase of yield and in the reduction of production costs even though collecting these residues implies in extra costs.

SOCIAL IMPROVEMENT: as related to the capacity of generating jobs, to the minimum feasible farm per feedstock (family owned agriculture x entrepreneur agriculture) and in as much as harvest mechanization rates, are concerned.

Some researchers suggest that bio-fuels might become a sizeable portion of the solution for poor countries to diversify businesses and ensure sustainable growth. According to Zarrilli (2007), several countries that have implemented bio-fuel development programs have presented noticeable growth in terms of new jobs whereby most arise in rural areas yet also at other linkage points along the productive chain.

According to Poschen (2007) - senior International Labour Organization's specialist on sustainable development - the number of jobs created in renewable energy sectors will double by 2020, generating approximately 300,000 new jobs. In the early phase of the bio-ethanol program in the U.S., around 147,000 jobs sprung at different economical sectors.

In 2008, the sugarcane industry in Brazil hosted 1,283,000 Brazilian workers, 481,662 of which in the ethanol industry, 575,083 in the sugar industry and 481,600 in the sugarcane production front, itself. This accounted for a total increase of 99.6% in the number of jobs as of the year 2000 (RAIS, 2008 apud Moraes, 2009).

Producing different bio-fuels implies in the existence of different production methods and thus this creates different kinds and volumes of jobs. Biodiesel production offers an improved scenario when it comes to job creation issues given that some crops (palm, jatropha and castor beans) can effectively be produced by small farmers. In Brazil, every 6 ha of palm yields one job (EMBRAPA CPAA, 2007). Corn and sugarcane however don´t support the development of small producers in such a significant manner since this agricultural activity calls for high production scales so as to be economically feasible. Once again, in Brazil, a sugarcane producer must hold at least 500 ha worth of planted area so as to mechanize harvests and not face economical loss (Mello e Paulillo, 2005, apud Camargo, 2007).

Furthermore, labour is replaced by machines at times of harvest. Sugarcane and corn can be mechanized, whilst palm cannot as yet make use of this alternative. According to UNICA (2007), a potential scenario whereby 100% of the sugarcane harvest in the State of Sao Paulo—the largest producer of sugarcane in Brazil—and in 50% of the rest of the country, is mechanized, would imply in 165,000 fewer job postings versus the number of workers in the year 2000. On the other hand, an expansion in the demand for more qualified workers ought to be expected in the sugarcane industry, in the sugar and ethanol industries and also in other sectors such as machines and service suppliers. Currently, machines already harvest more than 50% of the sugarcane produced within the state of São Paulo.

It is also fact that innovations in sugarcane and grain cultivation have promoted improved working conditions all over the world and likewise reduced eventual negative environmental impacts. As per Balsadi´s (2007, apud Camargo, 2007) statements, results of such innovations in Brazil are evident in terms of the employment legislation and also when it comes to the elimination of child labour, the increase of literacy rates and of salaries and benefits.

ENVIRONMENTAL IMPROVEMENT: as relative to energy balance, potential GHG emission reductions (carbon sequestration or avoided emissions) and cost reductions (US$/t CO^2e).

One of the most relevant underlying reasons favouring the consumption of bio-fuels lies is its environmental importance, especially considering the urgent need to reduce greenhouse gas (GHG) emissions (mitigation) so as to avoid the furthering of severe climate changes and their potentially catastrophic consequences.

The transportation sector ranks amongst those most energy active and thus accountable for, GHG emissions. If one adds current and projected transportation related CO^2 emissions, it becomes readily apparent that road transportation leads emission rankings, both at present and in the future (currently at 80% of total share) (IEA, 2005, and WBCSD, 2004). In this case, blending bio-fuels with fossil fuels plays a tremendous role in terms of diminishing the negative impacts of the transportation sector, on the world´s environment.

A study performed by the World Watch Institute (WWI, 2006) demonstrates that the energy balance (renewable energy in bio-fuels divided by fossil energy used to produce it) is positive for bio-fuel production and use (the entire productive chain). However, there are several differences amongst feedstocks for ethanol: corn in the USA (1.4), sugarcane in Brazil (8.3), wheat and beet in Europe (2). The same analysis is undertaken when dealing with biodiesel: oil palm (9), residues of vegetable oils (5.5), soybean (3), and colza (2.5). For instance, the sugarcane chain in Brazil and the oil palm chain in Indonesia and Malaysia do not use (or use minimal quantities of) fossil energy in the industrial process—only residues—ensuring great sustainability in the process and reducing GHG emissions.

A report issued by the International Energy Agency (IEA, 2004a) informs that bio-fuels can contribute with significant reductions in the amount of CO^2 emissions. When compared to gasoline, ethanol from sugarcane (Brazil) contributes with about 85% of the reduction; ethanol from grains (US and EU) contributes with 30% and beet ethanol (EU) with 45%. Cellulose ethanol (IEA) which grants 105% thus presents the highest CO^2 reduction level. In relation to diesel, biodiesel on the other hand, reduces the volume of CO^2 emitted by approximately 50%. At the same time, in terms of CO^2 reduction costs (US$/t CO^2) ethanol from sugarcane (Brazil) is the cheapest option amongst all bio-fuels (less than US$ 40.00), followed by the American ethanol made as of corn (over US$ 45.00), ethanol from grains in the EU (more than US$ 600.00) and their sugar beet ethanol (US$ 300.00).

With views to validating environmental improvements, the market might develop instruments such as sustainability certifications. The main bio-fuel certifications ideated to date arose from national governments, the private sector, non-governmental and international organizations. The certification process starts with the definition of sustainability principles that address environmental, social and economical concerns, establishes effective criteria, creates clear and precise indicators that allow for the quantification of benefits to achieve, defines an economically viable methodology and organizes monitoring systems (Mathews, 2008).

4.4 KEY FORCE RANKING AND CORRELATION MATRIX

Consolidated key forces were organized into a list. For ranking definition purposes, 27 experts from all continents were queried: Asia, Africa, America, Europe and Oceania. However, we only received 14 answers from the following countries : Argentina, Australia, Brazil, Canada, China, Japan, South Africa, France, the Netherlands and USA.

Experts were asked to analyze key forces and then classify these according to two variables, namely:

- ✓ Each key force´s degree of importance for the success or failure of the focal issue (mandatory blending targets) according to a ranking score ranging from 0 (low importance) to 10 points (high importance);
- ✓ Each key force´s degree of uncertainty according to a ranking score ranging from 0 (low uncertainty) to 10 points (high uncertainty).

Therefore, figure 1 shows an opinion map (perceptual map) identifying which factors are most important and most uncertain. Per specialized opinions, the most relevant factor for decisions concerning adding bio-fuels to either gasoline or diesel is the unit price of a barrel of oil. However, this is also mentioned as being the least certain, or predictable, factor.

Bio-fuel production capacity emerges as the most certain variable given that the amount of investment in traditional bio-fuel (1st generation) productive capacity and in cellulose bio-fuel (2nd generation) R&D development, is sizeable enough, to positively influence countries in their decisions concerning whether or not blending targets are worth adopting.

Setting aside the less relevant "clean vehicle adoption" aspect, the least important and second most uncertain (only short of oil prices) variables, according to experts, were those associated with the social and environmental aspects of bio-fuel production in as much as rural workers' living standards, use of disposable agriculture residues, positive balance of GHG emissions throughout the entire productive chain and other issues, is concerned. Thus, it seems that specialists are apparently most attentive to energy security and economic sustainability matters within their own economies as opposed to bio-fuel social and environmental impacts.

As foreseen, the decision to adopt or to do otherwise when it comes to flex-fuel automobiles barely influences those concerning mandatory blending targets. The main focus pertains to governmental incentives and restrictions as to domestic agriculture and the capacity to offer feedstock for the production of bio-fuels. Finally, uncertainties as to domestic protectionism are not of extreme relevance and are, furthermore, subject to positive modifications upon greater international trade of bio-fuels and feedstock.

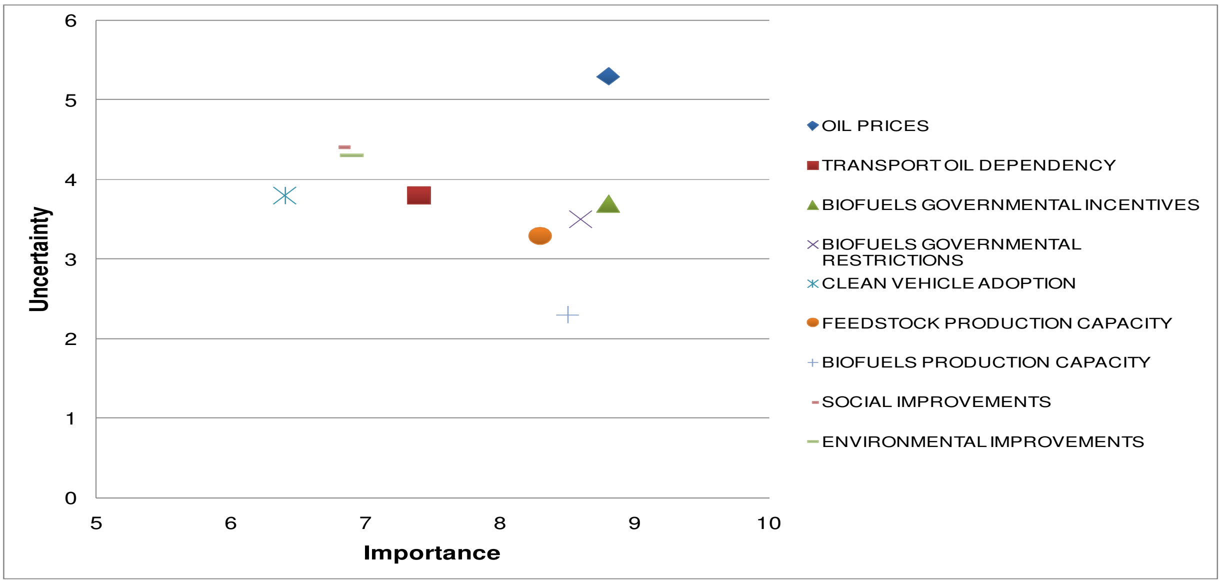

Fig. 1: Key Force Perceptual Map

Source: Prepared by authors.

Finally, a matrix of correlation is prepared to identify the relationships amongst the key forces, since trends are capable of influencing one another. Here, the "+"sign means that the occurrence of one key force positively influences the other. The "-" sign indicates there is a negative influence of one key force over another. Finally, the "0" sign means that there is no effect at all and the "±" sign means that one trend impacts another both positively and negatively.

For example, oil prices will have a positive impact on the adoption of clean vehicles if they reach levels whereby running on bio-fuels becomes a cheaper alternative. On the other hand, if oil prices are lower than that of bio-fuels, this is deemed a negative impact. Table 3 presents this perspective.

Table 3: Key Force Correlation Matrix

KEY FORCES	OIL PRICES	TRANSPORT OIL DEPENDENCY	BIO-FUELS GOVERNMENTAL INCENTIVES	BIO-FUELS GOVERNMENTAL RESTRICTIONS	CLEAN VEHICLE ADOPTION	FEEDSTOCK PRODUCTION CAPACITY	BIO-FUELS PRODUCTION CAPACITY	SOCIAL IMPROVEMENTS	ENVIRONMENTAL IMPROVEMENTS
OIL PRICES		±	±	±	±	±	±	**0**	**0**
TRANSPORT OIL DEPENDENCY			+	+	+	+	+	**0**	**0**
BIO-FUELS GOVERNMENTAL INCENTIVES				+	+	+	+	+	+
BIO-FUELS GOVERNMENTAL RESTRICTIONS					-	±	±	+	+
CLEAN VEHICLE ADOPTION						+	±	+	+
FEEDSTOCK PRODUCTION CAPACITY							+	±	±
BIO-FUELS PRODUCTION CAPACITY								±	±
SOCIAL IMPROVEMENTS									+
ENVIRONMENTAL IMPROVEMENTS									

Source: Prepared by the authors.

4.5 MANDATORY BLENDING TARGET SCENARIOS UP TO 2020

Since the international demand for bio-fuels depends on countries establishing mandatory blending targets, one might design scenarios for bio-fuel demand as of this institutional environment. To thus proceed, key analysis variables (or drivers) were required and these pertained to environment variables with the most power of influencing the focal issue (demand for bio-fuels), irrespective of their uncertainty, which are also capable of promoting the shaping of scenarios of contrast, depending on their varied, final condition.

In this sense, the last session selected key drivers by analyzing energy markets (oil, bio-fuels and feedstocks), new technologies (flex-fuel cars, hybrid cars, hydrogen cell, hydrolysis to cellulose ethanol and new agricultural varieties), political factors (governmental restrictions and incentives), economic forces (bio-fuels productivity, production costs and processing capacity) and sustainable forces (social and environmental improvements).

Chart 3 summarizes bio-fuel demand scenarios up to the year 2020, as perceived from the authors standpoint.

		"Pessimistic" Scenario **Countries reduce current targets USA (blending targets 15% -> 10%), China (blending targets 15% -> 10%) and EU (10% -> 5,75%)**	**"Expected" Scenario** **Countries maintain current targets**	**"Optimistic" Scenario** **Rise of current targets + adoption by other countries such as Russia and Japan**
1	*OIL PRICES*	• Discovery of new wells. • Increase of production. • Barrel at US$ 40.	• Steady production (at recent levels). • Low investments in prospecting new wells. • Barrel at US$ 80.	• Production drop by major suppliers located at unstable regions (outputs below historical average/figures) • Scarce investments in discovering new wells. • Barrel at US$ 120.
2	*TRANSPORT OIL DEPEN-DENCY*	• Consecutive economic crises. • Lower credits. • Strengthen public clean transportation and fewer personal vehicles. • Strengthen rail, water and airway transportation.	• Maintenance of economic prosperity, but with lower growth rates than in recent years.	• Rise of economic prosperity. • Maintenance of current economic growth rate and personal and commercial vehicle sales.
3	*GOVERN-MENTAL BIO-FUEL INCEN-TIVES*	• Countries with blending targets but no subsidies nor tax incentives. • Solely domestic regulation-oriented legislations (no international standardization). • Prioritizing of food production.	• Maintenance of current tax incentives and subsidies. • Movement towards international standardization. • Certification and regulation so as to transform ethanol and biodiesel into commodities.	• Rise of subsidies and tax exemption. • Considerable rise of efforts to promote standardization. • Social and environmental certification and regulation.

Continues

Continuation

		"Pessimistic" Scenario Countries reduce current targets USA (blending targets 15% -> 10%), China (blending targets 15% -> 10%) and EU (10% -> 5,75%)	**"Expected" Scenario** Countries maintain current targets	**"Optimistic" Scenario** Rise of current targets + adoption by other countries such as Russia and Japan
4	*GOVERN-MENTAL BIO-FUEL RESTRIC-TIONS*	• Rise of protectionism. • Strong international reaction against 1st generation bio-fuels produced at developing countries.	• Maintenance of agricultural protectionism in favour of local producers. • Growth of preferential markets; USA with CBI – Caribbean Basin Initiative, EU with EBA Agreement (British Sugar/Illovo, investments in Africa) and the SD&G Agreement (14 countries, mainly in Latin America). • The USA maintains import tariffs on ethanol. • Some EU countries break rules and non-tariff barriers imposed by the Commission, in order to achieve their own objectives.	• Production concentration in more competitive countries (mainly in the southern hemisphere). • Northern hemisphere countries prioritizing food production. • Strong growth of free market.
5	*CLEAN VEHICLE ADOPTION*	• Predominance of non-combustion powered vehicle sales (hydrogen + electric). • Less than 50% of flex-fuel or hybrid vehicles in fleets.	• Predominance of flex-fuel and hybrid vehicle sales. • 50% flex-fuel and hybrid vehicles in fleets. • Technological improvements mixing flex-fuel and hybrid (greater combustion efficiency).	• Predominance of flex-fuel vehicle sales. • Over 50% flex-fuel and hybrid in fleets. • Flex-fuel technological improvements (greater combustion efficiency).
6	*FEEDSTOCK PRODUC-TION CAPACITY*	• Considerable increase in world population. • Reduced climate change impact (1º C). • No major improvements in seeding technologies (historical agricultural yield growth drop).	• World population growth at historical rates. • Maintenance of historical agricultural yield growth rates. • Climate change impacts per expectations (3 °C). • Seeding technological improvements (technology matching loss in yield due to climate changes).	• Slow growth of world's population. • Strong impact of climate changes (3-5 ºC). • Great improvement in seeding technologies (GMO's, bio fertilizers, more resistant varieties) with major advances in yield (beyond climate change impacts).

Continues

Continuation

		"Pessimistic" Scenario Countries reduce current targets USA (blending targets 15% -> 10%), China (blending targets 15% -> 10%) and EU (10% -> 5,75%)	**"Expected" Scenario** Countries maintain current targets	**"Optimistic" Scenario** Rise of current targets + adoption by other countries such as Russia and Japan
7	*BIO-FUEL PRODUC-TION CAPACITY*	• Machinery and equipment industries as barriers. • Stabilization of industrial facilities • Major growth rate drop in the building of new plants.	• Removal of impairments on base industry. • New unit growth rate maintenance. • Introduction of production via hydrolysis of cellulose and shared production (conventional technology + hydrolysis).	• Major technological improvement (cellulose ethanol feasibility). • New plant building growth rate increase.
8	*SOCIAL IMPROVE-MENT*	• Slavedom and child labour at developing countries. • Concentration of rural properties (large farms).	• No risk of slavedom and child labour. • Coexistence of high-tech plantation models with family agriculture integration models.	• Strong pressure from international organizations to redistribute agricultural income. • Strengthening of agricultural contracts. • Total focus on family agriculture integration models.
9	*ENVIRON-MENTAL IMPROVE-MENT*	• Failure of the Kyoto Protocol, difficulties in binding new agreements, weakening of national and regional efforts so as to reduce climate changes. • New studies eliminate comparative advantages of bio-fuels of sugarcane and palm in terms of energy efficiency.	• Countries meet Kyoto Protocol targets; new agreements include developing countries (China, India and Brazil); regional agreements on emission control and successful climate exchanges at voluntary markets. • Sugarcane and palm bio-fuel energy efficient advantages maintain comparative advantages.	• USA participates in global agreements concerning emission reduction; targets become more ambitious, aligned with historical contributions; all countries adhere to targets, however per contribution. • Improvements in energy efficiency covering all kinds of bio-fuels (sugarcane, palm, corn, beet, cassava, wheat, *Jatropha curcas*), in sustainable production models and in hydrolysis.

Chart 3: Mandatory Blending Targets Scenarios Up To Y2020.

Source: Prepared by the authors.

There is little room for doubt concerning the strategic objectives of large bio-fuel producers and consumers. The recent approval of USA´s New Energy Bill placing a consumption demand of 36 billion gallons (or 136.8 billion l) of bio-fuels by 2022 so as to replace 15% of the domestic demand for gasoline, clearly demonstrates this nation´s concern as to energy security at times of rampant oil prices. On the other hand, the EU's intention to add 10% of bio-fuel for the road transportation sector purposes by 2020, will contribute with a 35% saving in terms of GHG emissions per bio-fuel unit, as compared to gasoline and diesel, likewise clearly expressing their concern as to climate changes. What do these two developments pose in common? They support domestic agriculture. Whilst the US aims to promote the feasibility of corn ethanol, the EU attempts to ensure the production of biodiesel as of colza. Nonetheless, the international bio-fuel market cannot rely on these two blocks.

Estimates indicate that by 2025, an increase of 50% in the world supply of food will be required (Borlaug, 2007) and there are only but few available agricultural areas (3.23 billion hectares). There is also the issue concerning how bio-energy areas are to be allocated. Envisioning such predictions is impaired since addressing such queries depends on car fleets and their development, on industrial demands, on the demand posed by individuals, on the institutional environment (% mandatory blending targets) and pertains to the behaviour of consumers.

However, the bio-fuel "tsunami" might subside should oil barrel prices drop under US$40, should there be less pressure as to global warming issues, should new technologies for the supply of ethanol and biodiesel not emerge and should inflation on food production experience a rampant rise. The authors do not support these possibilities and believe that the turmoil has found grounding and will trigger the following impacts on agribusiness systems:

- ✓ Increased land exploitation;
- ✓ Internationalization of agribusiness;
- ✓ Transfer of income from society to farmers;
- ✓ Improved image of agriculture;
- ✓ Reduced resistance towards genetically modified organisms (GMO´s);
- ✓ Serious impairment of the supply of fertilizers and consequent increase in that of bio-fertilizers;
- ✓ Provisioning issues concerning crop protection chemicals, machinery and industrial equipment;
- ✓ Accelerated and concentrated professionalizing of agribusiness.

5 FINAL REMARKS AND MANAGERIAL IMPLICATIONS

The first concern addressed herein is a macro-environmental analysis, vital to position the strategic planning and management of productive chains so as to focus on the analysis of countries interested in adding bio-fuels to their energy matrix.

Subsequently, the authors present a method to build scenarios for bio-fuel mandatory blending targets. Though simple, this method is mostly ground on Business Administration scenario planning literature and also on specialized opinions. Much of the herein presented reflects over five years worth of interaction between the authors and numerous players in the agribusiness feedstock system as pertinent to both ethanol and biodiesel.

The method initiates as of focal issue comprehension, analyses the current status of bio-fuel public policies and simulates the official potential demand in light of productive capacities. This is taken to effect under the STEP analysis process which seeks the most relevant and uncertain mandatory blending target key forces and finally the technique facilitates a straightforward logical thought exercise to outline three scenarios (pessimistic, optimistic and expected).

It is worth emphasizing that due to the dynamics of the subject matter itself, a significant portion of recent publications concerning scenarios may not hold true in the near future. Nevertheless, investments in R&D are so expressive, that bio-fuel technical-scientific developments should continue to be of great significance.

Finally, environmental analysis that includes the preparation of scenarios is meaningless should countries not follow suit and conduct local analysis for the sake of their own agribusiness systems and do not realize how to best adapt to the overall environment. A clear cut understanding of domestic industry strengths and weaknesses is mandatory. The underlying concept rests on the fact that strengths are subject to exploitation whilst weak points are prone to improvement once strategic projects are developed to address critical issues including innovation, communication, distribution and logistics, human resources, and production system coordination.

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