

# **Sustainability Assessment for Brazilian Ethanol: insights for the medium-term energy plan**

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## **1. Introduction**

Ethanol is considered an advanced biofuel with great potential to reduce global greenhouse gas (GHG) emissions, and currently sugarcane ethanol is an important contributor to a low carbon strategy for Brazil. To date, however, Brazilian ethanol planning has adopted a model focused on meeting demand, with an implicit assumption of the benefits of maximising ethanol production, without exploring in detail the broader consequences of the demand or responses to it. In Brazil, such planning processes are not subject under law to strategic level impact assessment, although some social and environmental analyses have been undertaken to support ethanol planning and decision making.

In this paper we argue that ethanol planning must be undertaken with recognition of a broader context and a more encompassing set of societal objectives, and we discuss the potential contribution of sustainability assessment processes to align ethanol planning with the principles of sustainability. We commence by briefly reviewing some recent contributions to the theory of sustainability assessment that draw upon systems theory, resilience thinking and transition management. We then describe the current state of planning with respect to Brazilian sugarcane ethanol, and identify Brazil's Decennial Plan for Expansion of Energy 2020 as a key document and the focus of our study. We then consider how sustainability assessment processes could inform medium-term sugarcane ethanol planning in Brazil, and identify three main areas for improvement.

## **2. Recent developments in Sustainability Assessment theory**

The term 'sustainability assessment' has been used to define the attempt to direct an initiative towards sustainability (Gibson, 2006; Gibson, Hassan, Holtz, Tansey, & Whitelaw, 2005; Hacking & Guthrie, 2008; Pope & Dalal-Clayton, 2011). Sustainability assessment can be an *ex-ante* assessment process to inform decision-making at either the strategic or project level, or an *ex-post* evaluation process, which seeks to identify opportunities for improvements in existing systems.

Pope and Dalal-Clayton (2011) assert that Sustainability Assessment requires adjustment to the approach and content of an assessment, rather than a new process. It is about applying an integrative and holistic concept of sustainability in the whole planning processes. Different areas of knowledge have contributed insights for acting towards sustainability, including through applications of systems theory, resilience thinking, ecological economics, and transition management.

Walter and Salt (2006) explore resilience thinking, and point out nine characteristics of a resilient world: diversity in all forms; ecological variability; modularity to be less susceptible to shocks; acknowledging slow variables associated with thresholds; tight feedbacks; social capital, promoting trust, well-developed social networks and leadership; innovation, with emphasis on learning, experimentation and locally developed rules; overlap in governance, with "redundancy" in the governance structures and a mix of common and private property with overlapping access rights; and valued ecosystem services in development proposals and assessments. Slootweg et al. (2011) discuss how resilience thinking can support strategic environmental assessment by strengthening the concept of sustainability.

Transition management theory, presented in Loorbach (2007), has as its goal to enable, facilitate and guide transitions to sustainability when the persistent problems require new approaches to deal with complexity of the modern society and its associated problems, and highlights the need for multi-actor processes, adopting an innovation focus besides improvement processes, dealing with uncertainties, and development of a large number of options and a long term view.

Gibson *et al.* (2005) present eight generic criteria for progress towards sustainability: socio-ecological system integrity, livelihood sufficiency and opportunity, intragenerational equity,

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intergenerational equity, resource maintenance and efficiency, socio-ecological civility and democratic governance, precaution and adaptation and immediate and long term integration. These criteria must be specified for the particular context to supply a comprehensive set of evaluation and decision criteria, as shown in recent publications (Duarte, Gaudreau, Gibson, & Malheiros, 2011; Gaudreau & Gibson, 2010; Gibson, 2011).

These examples of the state-of-art of sustainability thinking offer valuable insights and provide direction for the evolution of sustainability assessment. In this paper we apply these concepts in the context of Brazilian energy planning, and consider how sustainability assessment could help ensure that Brazilian sugarcane ethanol policy leads to positive contributions to sustainability.

### 3. Sugarcane ethanol in Brazilian Energy Planning

The central body responsible for energy planning in Brazil is the Ministry of Mines and Energy (Ministério de Minas e Energia - MME). An important supporting body for technical and strategic studies is the Energy Research Company (Empresa de Pesquisa Energética – EPE).

Four main documents provide the orientation for the Brazilian energy planning. The current long term document is the National Energy Plan (Plano Nacional de Energia – PNE), which includes a detailed diagnosis of the potential National Energy Matrix 2030 (Matriz Energética Nacional – MEN). For the medium-term, the Decennial Plan for Expansion of Energy (Plano Decenal de Expansão de Energia – PDE) presents demand and supply study findings for a horizon of ten years, setting a baseline scenario, which signals and guides the decisions of agents in the energy market, details which projects are to be implemented in subsequent years to meet the anticipated demand, and directs government investments. Supporting development of the PDE, the National Energy Balance (Balanço Energético Nacional – BEN) is an annual study that presents an updated diagnosis of energy generation and consumption in Brazil.

Regarding the forecast for ethanol in the medium term plan, the PDE 2020 expects total demand in this period to increase from 28.2 to 73.3 billion litres, 73 percent of which is earmarked for domestic consumption, while exports would increase from 1.8 up to 6.8 billion liters. Table 1 shows a summary of the main indicators related to the expansion of energy production and consumption in Brazil.

Table 1 – Forecast of fuel demand and issues related to the sugarcane industry between 2011 and 2020.

Indicator	2011	2020
Total demand for ethanol (billion litres)	28.2	73.3
Brazilian exports of ethanol (billion litres)	1.8	6.8
Sugarcane amount to meet ethanol and sugar demand (million tonnes)	625	1,126
Area of sugar cane required to meet demand (million hectares)	8	12.6
Car fleet (million units)	29 (2009)	56
Gasoline (types A + C) demand (billion litres)	57,425	50,268

Source: drawn from MME & EPE (2011).

The PDE 2020 projections are based on economic and demographic projections and also on trends in the industrial, residential and transport sectors. The forecast considers that the number of cars will practically double in Brazil from 2009 to 2020 and considers those cars will be mainly fueled by ethanol, given the decrease of gasoline consumption. Based on this, the Brazilian energy planning goal is to maximize the production of ethanol for domestic and external markets.

After presenting the demand and supply study findings, the PDE 2020 presents a synthetic socio-environmental analysis. The main issues addressed in this section are the conversion of pasture and agriculture areas to sugarcane, the availability of water, biodiversity threats and employment levels.

The plan identifies the two most important areas for sugarcane expansion, analyzing the increase in sugarcane relative to pasture and sugarcane relative to agriculture. However, the analysis is limited to the 2011-2012 period for the eleven mills that were already in the implementation phase. The study assumes the expansion will prioritize current pasture areas, and

shows the percentages of conversion in two geographic areas. In the Area 1, sugarcane lands will increase from 19 to 26 percent, and in Area 2, from 21 to 31 percent. The socio-environmental analysis also notes limitations in the two areas for expansion. In Area 1, the main limitations are the existence of protected areas and low native vegetation cover, currently at 14 percent, which implies the need for better care of the remaining fragments of native vegetation. In Area 2, the main limitation is the high water demand due to the demands from agribusiness (MME & EPE, 2011). The Plan points out there are already clear trends of land use change and reaffirms the importance of zoning to regulate sugarcane expansion, as had been done in Sao Paulo state. The analysis concludes that despite these limitations expansion can occur in a sustainable manner and is technically feasible.

With respect to employment in the sugarcane industry, the plan shows the ratio of agricultural jobs to industrial jobs has decreased in recent years, and despite significant expected expansion the agriculture sector will suffer a loss in employment, with a reduction of 18,200 jobs from a total of 207,000. The main cause is sugarcane mechanization, which increases productivity from 8.7 tonnes per day per employee with manual cutting up to 300 tonnes per day per employee in the mechanized process.

#### **4. Sustainability Assessment contributions for Ethanol Planning**

Sustainability assessment utilizing the concepts discussed previously can potentially make extensive and broad contributions to ethanol planning processes in Brazil. For the purposes of this paper, we focus on the application of sustainability assessment to the medium term plan, the PDE. PDE 2020 provides the basis for the main funding decisions affecting expansion of sugarcane industry, so all the important issues must be addressed before the final decision making to guarantee the plan is well designed to serve the medium and long term national interest.

The way in which a plan is framed plays a vital role in determining the potential sustainability outcomes of the plan. Framing can be usefully considered in terms of the strategic question the planning process is seeking to answer. Based on the decision questions presented by Morrison-Saunders & Therivel (2006), it can be argued that the PDE 2020 is seeking to address the strategic question “how we can achieve ethanol demand X?”. We argue that instead of this, the more appropriate strategic question is “how much ethanol can be produced in a sustainable way in Brazil?”

A full sustainability assessment to address this proposed question would entail clarifying the purposes of a medium term national ethanol plan from a sustainability perspective, identifying the main planning options (linked to alternative future scenarios), developing context-specific criteria for sustainability-based evaluations and decisions, comparing the potential effects of the various options in light of the criteria, and determining the implications – all with the engagement of relevant stakeholders, experts and other interested parties.

Undertaking and reporting all that is clearly not possible in this paper. Instead in the following sections, we survey a select set of key considerations in such an assessment, in order to illuminate the scope, significance and possible contributions of a sustainability-based approach. We propose three starting points, related to the objectives of the PDE, that could help to improve the plan as a vehicle for progress towards sustainability: the establishment of clear links to other sectors, the development of a desired scenario and alternative paths to reach it, and defining required actions for other levels/sectors to guide a sustainable sugarcane expansion.

##### **a. Links among plans**

Both land use and transport planning have significant implications for and interactions with ethanol planning. In terms of land use strategy, two of the most crucial limits to development of energy from biomass are the competition with food crops and forests for land. Ethanol must be produced without threatening food security and sovereignty or compromising biodiversity conservation, and this requires clear rules to guide the territorial development. A long-term territorial plan should also be developed, considering an integrated forecast of biodiversity and agriculture development, including attention to land uses for cattle, soy, corn, wheat, fruits, vegetables and non-food agriculture (e.g. wood, eucalyptus, rubber trees, flowers, energy crops and family agriculture).

Current Ministry of Agriculture studies show there are 91 million hectares available for agriculture and predict expansion of several agribusiness and associated crops. Hence even if sugarcane didn't fill these new areas, other crops probably would, so agriculture regulation is fundamental to guide the development of agriculture sector. The Ministry of Agriculture has also published a specific zoning plan showing there are 64.7 million hectares of soil suitable for cultivation of sugarcane (MAPA & EMPRAPA, 2009), which demonstrates the support of government for the expansion of sugarcane.

Regarding transport, the PDE 2020 predicts increased private transport relative to collective transport. Considering the current chaotic state of mobility in several big and medium sized Brazilian cities, this forecast points to an undesirable and probably unrealistic future. There are national and local level sustainable mobility plans, centred on public transit improvements, that are in the development phase; but it seems that they are not yet influencing predictions about the demand for vehicles, and a stronger strategy must be developed to inform fuel projections.

Other important implicit strategies are evident in, for example, various rural development and employment initiatives that should influence ethanol planning decisions, but these considerations are not yet reflected in explicit plans or addressed in ethanol planning.

## **b. Sustainability scenarios**

The PDE 2020 is focused on anticipating and meeting future ethanol demand as predicted by current trends, and does not explore other future scenarios. Drawing a desired scenario or vision for the future is an important step in planning for sustainability, as it enables participants to identify problems in the predicted trends and then develop policies to redirect society towards better levels of well-being and environmental quality. The scenario development process stimulates debate and new thinking, and encourages analysis that considers the full range of sustainability considerations.

Aligned with the development of a shared vision for ethanol and energy in Brazil, the plan could also explore several options to reach a desired state. Examining and comparing a wide range of alternatives increases the robustness of the resulting plan, and has potential to shape a more adaptive plan, which is more likely to meet sustainability challenges.

Another important element for scenario development is the inclusion of uncertainties and risks in the analysis. For the sugarcane case, one of the most important uncertainties concerns the potential impacts of climate change on agriculture, which could worsen climate variability (e.g. droughts, storms), thereby reducing agricultural productivity. The huge increase in large areas of sugarcane monocrops could also bring important but uncertain adverse effects on biodiversity, especially in areas where the connectivity among fragments of remaining nature vegetation is not established (SMA, 2008). Another area of uncertainty involves the limited capacities of small cities to accommodate the arrival of large sugarcane companies and their workers, without undue negative effects for local society. This is a very sensitive issue, because several cities in the expansion area lack the necessary infrastructures to receive large companies, and the investments must be shared by industry and higher levels of government in order to prepare the city to withstand new pressures. Putting the responsibility for local issues in the hands of individual companies can be expected to cause overall adverse impacts that the government will have to bear later.

In summary, scenario planning could guide the identification of the main planning options to assess – the most promising, feasible and flexible paths to a future with broadly desirable qualities.

## **c. Required actions for other levels/sectors to guide the expansion**

In the evaluation of planning options for moving towards the best future scenario, one key component would be the examination of existing and possible government programs that could support the development of the sugarcane industry in the most sustainable way possible. Since the government is not directly responsible for the production of ethanol, it is necessary that the rules for the proper production by the private sector be established in advance.

As Brazil's various states have had different experiences in regulating the sugarcane sector, useful learning could be facilitated through sharing experiences from the most successful cases and undertaking collaborative efforts to improve regulation in all sugarcane producer states. Sao Paulo state has advanced experience in regulating the sugarcane industry, including use of specific rules for the environmental licensing process based on an agro-environmental zoning and a voluntary

cooperation protocol to guarantee a higher level of industry performance. Agro-environmental zoning indicates areas where additional actions are necessary to reduce water consumption, to protect biodiversity among other aspects (SMA, 2008). The cooperation protocol is focused on the ten most important impacts of the sugarcane industry, and monitors the performance of the mills annually; those ones that meet the requirements receive a seal of compliance from government (SMA, SAA, & ORPLANA, 2008; SMA, SAA, & UNICA, 2007). However, despite the efforts and good results in Sao Paulo state, more research is needed to understand the sustainability impacts of these set of policies and fill the existing gaps, in order to seek continuous improvement.

The PDE 2020 recognizes Sao Paulo state initiatives, but does not analyze the regulatory context and capacity of other states to handle the expansion of ethanol and its side positive and adverse effects in a way that maximizes sustainability gains. Among the measures to be adopted are state zonings of water availability to identify areas where the consumption needs to be lower; specific rules for biodiversity protection in each biome, and social and environmental indicators for the monitoring of ethanol expansion. The plan has the potential to highlight the requirements to guarantee a better development of the sugarcane industry, and even direct public funding to fulfill certain requirements, but this potential is not yet realized.

## 5. Final considerations - planning for sustainability in a complex world

The conclusion of the PDE 2020 socio-environmental analysis challenges us to incorporate the concept of sustainability in energy planning and this paper has pointed out some opportunities for such improvement. In order to illustrate a suitable design for a sustainability-based strategic assessment for the Brazilian ethanol expansion policy, this paper explored three fundamental elements of the structure of the energy planning, with the aim of expanding the horizons of PDE 2020 to explore sustainability contributions in a more holistic way. These elements are the establishment of clear links to other sectors, the development of a desired scenario and alternative planning paths to reach it, and defining required actions to other levels/sectors to guide a sustainable sugarcane expansion.

It is a challenge for researchers and practitioners to find the connections between the most advanced sustainability theories and the concrete world of the energy planning, and this work is an initial attempt in this direction. We believe that the proposed approach to ethanol planning in Brazil could be more successful than the current model, in ways that could bring positive sustainability and resilience contributions for energy, agriculture and environment futures in Brazil.

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