# BUILDING INSTITUTIONAL CAPACITY FOR SUSTAINABILITY AND CLIMATE CHANGE POLICIES

By

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# ABSTRACT

The main purpose of this thesis is to analyze different strategies pursued by developing countries to strengthen institutional capacities for sustainability and climate change policies. Throughout the chapters, I analyze sustainability and energy policies for the ethanol industry and national efforts to build institutional capacity for climate change policy. Each case analysis focuses on different experiences in separate countries.

The first chapter explores the Brazilian pathway to increase sustainability standards in the biofuel industry with the aim of understanding the role played by international standards and domestic policies to foster more sustainable practices by the private sector. In the conclusion, I argue that international standards played a significant role linked to market opportunities, becoming a driving force to link sustainability and competitiveness policies in development countries, but it requires an important effort from domestic policies to facilitate private upgrade toward more sustainable practices.

The second chapter, “Making Ethanol an International Commodity: Challenges for the Brazilian State”, analyzes Brazil’s challenges and difficulties in making ethanol an international commodity as part of its agro-energy agenda. The chapter describes the complexities in building a global market, emphasizing the institutional and political dimensions of the market formation process from the standpoint of a developing country. The conclusions discuss the definition and limits to state capacities in open economies, analyzing the difficulties in governing the domestic market, and in building governance structures at the international level, together with the demand building processes, given changing standards and requirements at international markets .

The third chapter, “Strengthening institutional capacity for climate change policy in Chile”, analyzes Chile’s efforts to build evidence about its contribution to climate change and to define its mitigation policies. Specifically, I discuss the process of co-production of evidence for capacity-building, and show the usefulness of a participatory process,

facilitating the development of a community of practice on climate change policies including people from the public, private and academic realm.

# CHAPTER 1

# THE BRAZILIAN EXPERIENCE IN FOSTERING SUSTAINABILITY IN THE BIOFUEL INDUSTRY

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Growing concerns about climate change have prompted developed countries to adopt policies to improve the sustainability of their transport sector. Among these, the introduction of biofuels was considered at the beginning of the 2000 a viable possibility in the short term to replace gasoline and diesel as a transition toward the electrification of the transport sector. However, some nongovernmental organizations and academics questioned environmental and social sustainability of biofuels. It was stated that biofuel production processes do not always meet the expected net lifetime greenhouse gas (GHG) emission rate or cost-performance targets, and certain conventional biofuels were criticized for causing deforestation and adding pressure on agricultural land that is needed for food production.

Among the countries in the global south, the Brazilian experience is an interesting case study that can contribute to our understanding of the processes of building domestic policies in developing countries as a necessary complement to international sustainability standards to produce more sustainable alternative for road transportation fuels. Thus, this article will describe the Brazilian pathway to increased sustainability in the biofuel industry, which is characterized as a state led process that implies a close cooperation between the state and the private sector in the domestic and international realm to build a governance structure to foster competitiveness policies and environmental regulation that are the necessary complement to international sustainability standards.

## 1 INTRODUCTION

Growing concerns about climate change and the need to implement measures to fulfill the commitments under the Kyoto Protocol[1] prompted developed countries to adopt measures to reduce their greenhouse gas ("GHG") emission levels. To achieve this goal, most developed countries have implemented policies to improve the environmental sustainability of their transportation sectors (ECCP, 2003).

Transport is a significant contributor to overall GHG emissions. The sector as a whole accounted for approximately 13% of overall GHG emissions and 24% of $CO_2$ emissions from fossil fuel combustion in 2006 (ITF, 2010). It is expected that in the coming twenty years, in the absence of any corrective measures, global transport emissions will grow by 38%, creating a great challenge to achieving climate-change goals (ITF, 2010).

[1] "The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. . . . [I]t sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions." For a more detailed description, see Kyoto Protocol, United Nations Framework Convention On Climate Change, http://unfccc.int/kyoto_protocol/items/2830.php (last visited Sept. 21, 2012).

Most policies to improve the environmental sustainability of transportation include measures to increase fuel efficiency and to substitute gasoline with renewable energies (European Parliament, 2009). Among these renewable energies, biofuel was considered the most viable possibility in the short term to replace gasoline and diesel in the path toward the total electrification of the sector. Biofuel requires only minor adjustments in current automotive technology and fuel-distribution systems (Ackom et al., 2010), it can be blended up to 25 percent with gasoline or diesel to partially reduce fossil fuel consumption (CGEE, 2009) and the production cost of some first-generation biofuels will become competitive in the global market (CGEE, 2009).

However, some nongovernmental organizations and academics have questioned environmental and social sustainability of biofuels (Fernandes et al., 2010). Recent estimates indicate that current biofuel production processes do not always meet the expected net lifetime GHG emission rate or cost- performance targets, and certain conventional biofuels have been criticized for causing deforestation and adding pressure on agricultural land that is needed for food production (Ackom et al., 2010).

In response to these concerns, the United States and the European Union, which had already opted to support biofuel through the implementation of consumption targets, have included sustainability criteria to guarantee the environmental sustainability of their biofuel consumption, with the ultimate goal of meeting the environmental goals proposed in their climate change and energy policies (Galli, 2012). In the European Union, the Renewable Energy Directive ("RED") has imposed unilateral limits, establishing penalties (such as limited access to the EU market) and standards (which involve meeting sustainability criteria set by international agreements with the European Union or by creating voluntary certification schemes) (European Parliament, 2009, at 17, 20–24). The assumption that lies behind this Directive is that the establishment of these requirements will generate motivation to improve biofuel production systems by creating incentives to create better technology, while ensuring that biofuel production is not carried out in areas rich in biodiversity (European Commission, 2010).

When it comes to discussions about the sustainability of biofuels, most attention is given to the efforts of developed countries to set appropriate standards to influence production in the global south (Giovanucci & Ponte, 2005). However, it is important to acknowledge the parallel path adopted by countries in the global south, which are expected to be important players in the global market to meet biofuel consumption targets in the United States and Europe (Jank et al., 2007). While biofuels can be produced from many different crops, it is expected that a substantial portion of the 10 percent-target-use of biofuels for road transport fuel in the European Union may come from ethanol produced from sugarcane from Brazil, potentially making Brazil the most important economic partner of the United States and European Union in the biofuel market (Laborde, 2011).

Among the countries in the global south, Brazil's experience of improving sustainability in the ethanol industry provides an important case study (Galli, 2012). Brazil is a world leader in the production of sugarcane- based ethanol (Ministry of Agriculture, 2010). Its industry began in 1970s, mostly for energy security reasons. Over time, ethanol has become the cleanest alternative for gasoline in the transport sector, making an important contribution to Brazil's environmental sustainability objectives.

Since the 2000s, Brazil's private and public sectors together have identified environmental sustainability as a central benefit of ethanol's advantages and as a factor that needs to be improved over time to maintain Brazil's competitiveness in the national and international market. Thus, Brazil has pursued a series of policies to improve the performance of its biofuel industry (Guardabassi, 2011, pag 40, 43,), following a path toward more sustainable production, even when most of its production is currently geared toward the domestic market (Ministry of Agriculture, 2010).

This article will describe the Brazilian pathway to increased sustainability in the biofuel industry[2]. This increase is characterized by a close cooperation between the state and the private sectors. This strategy has benefited both the international and the domestic realm. At the international level, Brazil has actively participated in defining the sustainability standards that differentiate its ethanol from other sources of biofuel and to organize a joint response between the public and private sector to overcome the potential technical barriers to trade. Additionally, the Brazilian government and private sector have worked to promote the sustainable production of biofuel in other parts of the global south to increase supply, which is an important component of its international cooperation policy with other developing countries.

Within the domestic realm, Brazil has worked to implement research and development policies to support improvements in production and increase the sustainability of ethanol

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[2] The content of this paper is based on personal interviews of stakeholders of the Brazilian ethanol industry conducted in Brazil in 2011, and the analysis of secondary information.

by implementing new regulations and domestic standards. But Brazil's process has not been without controversy or difficulty. Domestic interests and priorities in the environmental and economic realms have affected Brazil's policy agenda. However, the country has adopted concrete measures to improve ethanol production, even when some challenges remain unresolved. The Brazilian experience is an interesting case study that can contribute to our understanding of the process of building domestic policies in developing countries that are a necessary complement to international sustainability standards to produce more sustainable alternative for road transportation fuels.

## 2 BIOFUELS AND SUSTAINABILITY CONCERNS

Sustainability has become one of the defining concerns of the current industrial era, and it is a recognized criterion of public and political acceptance (IEA, 2010). It is classically defined in three forms: economic, social, and environmental (Shehaan, 2009, pag 318–319). There is not a simple definition of sustainability, but the overall concept entails achieving a quality of life that can be maintained for generations (Diaz-Chavez, 2011, pag 5763, 5764). Sustainable development is a combination of activities that can be expected to improve the human condition in a maintainable manner (Diaz-Chavez, 2011, pag 5763, 5764).

Sustainable alternatives to fossil-based liquid transportation fuels were originally defined as sustainable if they were sourced from renewable feedstock, such as biomass (Ackom et al., 2010); however, the public and political support for the fuel industry has changed, and the industry's "social license to operate" and ability to maintain its political support (e.g., through funding and blending targets) hinges upon demonstrating positive environmental performance (Ackom et al., 2010).

In recent years, biofuels have been questioned for their potential disruption of the food supply, their impact on biodiversity, their possible reduction of water quality and water availability, and their lack of a direct benefit to those directly affected by biofuel production (Walter et al., 2011). Additionally, doubts have been raised about the actual benefits of biofuels regarding the mitigation of GHG emissions, especially when indirect land-use change (“ILUC”) is taken into account (Fargione et al., 2008).

Regarding their socioeconomic impact, it has been argued that biofuel crops could compete with food production, threatening food supply security and adding pressure onto agricultural land that is needed for food (Runge & Senauer, 2007). The expansion of biofuel production also raises concerns about the potential negative impact on rural populations, both because of its effect on settlements and domestic migration and because of its impact on land concentration due to the scale of the production process and the characteristics of the technology involved (Ministry of Development, Industry and Foreign Affairs, 2007).

In terms of its environmental impact, biofuel’s contribution to the reduction in GHG emissions has faced scrutiny because of the negative effects of the extensive land required for biofuel production and the potential impact on deforestation (Smeets et al., 2008). Furthermore, there are concerns about biofuel’s energy balance when considering the net impact of their lifecycle production process (Davis, 2009). When fertilization, transport, and emissions from deforestation, burning, peat-drainage, cultivation and soil-carbon losses are taken into account, the energy balance tends to be more negative than neutral (Davis, 2009).

According to a recent study by the Organization for Economic Cooperation and Development ("OECD"), only a few technologies in biofuel production have a reasonable greenhouse gas emissions balance—even without taking into account the carbon emissions effected through land-use change (Doornbosch & Steenblik, 2007). Among current technologies, only sugarcane- based ethanol in Brazil; ethanol produced as a by-product of cellulose production in Sweden and Switzerland; biodiesel from animal fats; and used cooking oil can substantially reduce GHG emissions as compared with gasoline and mineral diesel (Doornbosch & Steenblik, 2007). The other conventional biofuel technologies typically deliver GHG reductions of less than 40 percent compared with their fossil-fuel alternatives (Doornbosch & Steenblik, 2007).

One of the most important concerns about biofuel's environmental sustainability is the indirect land-use change effect (European Commission, 2010). This effect is defined as the impact of producing biofuel feedstock on land directly converted from another type of agricultural land (Delzeit, 2012). It is postulated that the carbon emissions from such land-use change have to be included in the overall calculation of greenhouse gas emissions of the specific biofuels (Walter et al., 2011). Moreover, if biofuels are instead cultivated on existing agricultural land, it may then displace other crop production. Ultimately, this may lead to the conversion of rich biodiverse land into agricultural land

(Delzeit, 2012). Through this route, extra biofuel demand will lead indirectly to land-use change (European Commission, 2010).

Measuring ILUC effects is a complex matter with no clear consensus on the modeling and quality of the data available to support conclusive results (European Commission, 2010). ILUC measurements concern future impacts, which are inherently uncertain, as future developments will not necessarily follow the trends of the past (European Commission, 2010). Moreover, the estimated land-use change can never be validated, as ILUC is impossible to directly observe or measure (European Commission, 2010). However, there is a growing consensus about the necessity of including policies to address ILUC impact when evaluating biofuel's environmental sustainability (European Commission, 2010).

## 3 THE UNITED STATES AND EUROPEAN UNION'S SUSTAINABILITY CRITERIA

All these concerns about the sustainability of biofuels have demanded action from policymakers and biofuel producers to adopt policies to substitute gasoline production with an alternative that might make a real contribution to GHG emission savings. Considering that both the United States and European Union support the development of a domestic biofuel industry and both have adopted biofuel-consumption targets, the path taken by these entities has focused on defining standards that affect biofuel production domestically and in the global south (Government of the United States, 2005). This article will focus mainly on Brazil's strategies and policies, but I will first describe the changing international context by analyzing the way new policies and standards in the world's largest markets have shaped the biofuel market.

## 3.1 THE UNITED STATE'S SUSTAINABILITY CRITERIA FOR BIOFUEL PRODUCTION

The Renewable Fuel Standard ("RFS") Program was launched in 2005 and established the first renewable-fuel volume mandate in the United States (Scarlat & Dallemand, 2011). In its first version, the RFS program required 7.5 billion gallons of renewable fuel to be blended into gasoline by 2012 (EPA, 2010). Under the Energy Independence and Security Act of 2007 ("EISA"), the volume of renewable fuel required to be blended into transportation fuel it is expected to increase from 9 billion gallons in 2008 to 36 billion gallons by 2022 (Government of the United States, 2007). Additionally, the program established new categories of renewable fuel and set separate volume requirements for each one depending on their GHG emission reduction EISA required the United State's Environmental Protection Agency ("EPA") to apply lifecycle GHG performance threshold standards to ensure that each category of renewable fuel emit fewer greenhouse gases than the petroleum fuel it replaced (Government of the United States, 2007).

Based on this methodology, the Act identified three types of biofuels: cellulosic ethanol, biomass diesel, and "other advanced" (Schnepf & Yacobucci, 2012). The use of renewable fuels in the United States will be required in order to reduce GHG emissions by at least 20 percent by 2022, with 58 percent of all renewable energy coming from cellulosic ethanol and other advanced biofuels (EPA, 2010b). Like Europe, the United

States will grandfather the GHG emission standards for existing installations until 2022 (European Commission, 2010).

## 3.2 EUROPEAN UNION SUSTAINABILITY STANDARDS

The European Union adopted the Fuel Quality Directive ("FQD") in 2007 and the Renewable Energy Directive ("RED") as part of its energy and climate change policies (Laborde, 2011). The FQD requires a 6 percent GHG reduction in transportation fuels by 2020 (European Parliament, 2009). The European Union reiterated its support for mandatory biofuel targets, calling for 10 percent use in 2020, subject to production sustainability and the commercial availability of second-generation biofuels (Levidow, 2010).

The European Union Directive requires that the share of energy from renewable sources must be 20 percent by 2020, with at least 10 percent use in transportation fuel (European Parliament, 2009)[3]. While the 10 percent obligation is equal among all member states, the overall 20 percent obligation represents only a EU average, with markedly different targets for individual member states (European Parliament, 2009)[4]. Both RED and FQD also have sustainability criteria (European Parliament, 2009)[5]. RED requires that generate

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[3] See Council Directive 2009/28, 2009 O.J. (L 140) 8 (EC).

[4] See id. at annex I. Countries targets vary from 10% in the case of Malta and 49% in the case of Sweden. Id

[5] See id. at art. 17(1); see also Council Directive 2009/30, art. 7b, 2009 O.J. (L 140) 1 (EC). These two instruments lay down identical sustainability criteria.

a GHG emissions savings of at least 35 percent (European Parliament, 2009)[6]. This increases to 50 percent at the start of 2017 for all installations, and to 60 percent at the start of 2018 for installations that start production on or after January 1, 2017 (European Parliament, 2009)[7].

RED also contains land-use related criteria. For biofuels to be counted toward member states' renewable energy targets, or for members states to be eligible to receive financial support, their biofuels must not be made from feedstock obtained from land with high biodiversity value,[8] land with a high carbon stock,[9] or from land that was peat land (unless it is shown that the cultivation of the crops did not involve draining previously undrained soil) (European Parliament, 2009)[10]. Compliance with these criteria is not a

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[6] This requirement took effect on Dec. 5, 2010, Council Directive 2009/28, art. 27, 2009 O.J. (L140) 1 (EC), except in relation to installations in operation on Jan. 23, 2008, which are exempt until 1 April 2013, id. at art. 17(2). This is compared with a baseline scenario of 83.8gCO2eq/MJ laid down in the FQD. See Council Directive 2009/30, annex IV, 2009 O.J. (L 140) Part C (19) (EC). Also, see SEC (2011) 129 final concerning the mass balance verification method used for assessing compliance with the sustainability criteria in accordance with Article 18(2) of Council Directive 2009/28.

[7] Council Directive 2009/28, art. 17, 2009 O.J. (L 140) 2 (EC). 29gCO2eq/MJ will be deducted for biofuels produced from severely degraded or heavily contaminated land that was not used for agriculture or any other activity in January 2008. Council Directive 2009/28, annex V, 2009 O.J. (L 140) 8–9 (EC).

[8] This includes land, which has or had this status on or after January 2008. This would include primary forest and highly biodiverse grassland. The concept of highly biodiverse grassland is defined in Article 17(3)(c) of Council Directive 2009/28 and the criteria and geographic ranges for identifying this are to be set out by the Commission. To this end, it conducted a public consultation on this theme. However, no Commission decision has yet been published. Land enjoying high biodiversity value also includes nature protection areas designated by the relevant competent authority. Subject to a Commission decision, new areas recognized by international agreement or by the IUCN can be taken into account. A number of exceptions apply and the European Committee on Standardization (CEN) is currently working on the kind of evidence that needs to be provided to rely upon these. See Council Directive 2009/28, art. 17, 2009 O.J. (L140) 3(a), (c) (EC).

[9] This refers, for example, to land which was wetlands or continuously forested in January 2008 and which no longer has that status. See Council Directive 2009/28, art. 17, 2009 O.J. (L 140) 4(a)–(b) (EC).

[10] Council Directive 2009/28, art. 17, 2009 O.J. (L 140) 5 (EC).

precondition for access to the EU market, but compliance is necessary if transportation biofuels or bioliquids for other uses are to be taken into account for the renewable energy targets (Scott & Trubeck, 2011). Compliance with the land-use standard will be assessed on the basis of company information, via voluntary certification schemes, or through bilateral and multilateral agreements (European Parliament, 2009).[11] At the time the RED was enacted, only Brazilian ethanol was project to fulfill the future 60 percent criteria for GHG savings in 2017 (Levidow, 2011).

In 2009, the EU's sustainability criteria did not include any measures regarding ILUC (European Commission, 2009). To address ILUC issues, the EU commission deferred the discussion until December 2011, when the Commission would report on ways to calculate ILUC and ways to minimize its impact (European Parliament, 2009)[12] To fulfill this compromise, the Commission services hired experts to develop global models predicting the impact of biofuel consumption and the ILUC effects. The commission held a public pre-consultation in 2009 to address ways of minimizing the impact of ILUC[13] (European Commission, 2009).

[11] Council Directive 2009/28, art. 21, 2009 O.J. (L 140) 2 (EC).

[12] Council Directive 2009/28, art. 19, 2009 O.J. (L 140) 6 (EC).

[13] The Commission launched a number of analytical exercises in order to better understand the magnitude of these impacts: i) Global trade and environmental impact study of the EU biofuels mandate, ii) Impacts of the EU biofuel target on agricultural markets and land use: a comparative modeling assessment, iii) The impact of land use change on greenhouse gas emissions from biofuels and bioliquids – literature review, iv) Indirect land use change from increased biofuels demand – comparison of models and results for marginal biofuels production from different feedstock.

In 2010, the Commission held a public consultation to fully address the policy options that might inform the EU renewable energy policy (European Commission, 2010c). The public consultation addressed three main concerns. The first was about the legitimacy of the analytical work conducted as part of the Commission's analysis for determining the impact of ILUC resulting from the production of biofuels; the second, was about the significant differences between the categories of biofuels to be considered in the policy alternatives; and lastly was about the EU action needed to address ILUC and what course of action should be taken (European Commission, 2010c).

# 4 BRAZILIAN ETHANOL PROMOTION POLICIES: FROM ENERGY SECURITY TO SUSTAINABLE PRODUCTION

Brazil is the global leader in the production of sugarcane-based ethanol (CGEE & BNDES, 2008). Over the last thirty years, ethanol has played a relevant role in the domestic energy matrix (CGEE & BNDES, 2008). In 2009, ethanol met about 23 percent of its road transport fuel demand (CGEE & BNDES, 2008). To reach this goal, Brazil took advantage of its natural resources, including its ideal location in the sub-tropical zone to produce sugarcane (CGEE & BNDES, 2008). It has successfully taken the lead in the generation and implementation of modern, tropical agriculture technology and has developed a robust agro-industry with the conditions to be competitive internationally (Ministry of Agriculture, 2006). In addition its favorable conditions for biofuel production (including weather, rainfall, land availability, and working force), Brazil has taken advantage of its long-term experience with sugarcane production. It has also promoted technological developments, productivity improvements, and an institutional capacity to support the development of the sugarcane and ethanol industry through the implementation of numerous public policies.

Sugarcane production and the ethanol industry have a long tradition in the Brazilian economy (Ministry of Agriculture, 2006). Brazil produces two types of sugar- based ethanol: hydrous and anhydrous (Ministry of Agriculture, 2006). The former is used to power vehicles equipped with pure ethanol or flex-fuel engines, while the latter is mixed with gasoline to reduce petroleum consumption (UNICA & APEX, 2009).

The first policies affecting the development of the ethanol industry started in 1930s (Hira & de Oliveira, 2009). At that time, the main objective was to protect the domestic sugar industry and avoid the negative impact of sugar prices fluctuations (Hira & de Oliveira, 2009). Thus, in 1931, the Brazilian government launched a federal decree establishing mandatory blending of ethanol and gasoline and set guidelines for its transportation and commercialization (Moreira & Goldemberg, 1999).

In the early 1970s, changes in external conditions created an opportunity for the ethanol industry's expansion in the Brazilian energy matrix (Hira & de Oliveira, 2009). Brazil, like many other net importers of oil in the world, faced the oil price shock, along with a substantial drop in sugar prices (Hira & de Oliveira, 2009). During this period, Brazilian President Ernesto Geisel decided to encourage the production of ethanol to ensure energy security and to control the macroeconomic impact of fluctuations of petroleum prices. As a result, in 1975, the Brazilian government launched the National Alcohol Program ("PROALCOOL") and implemented policies to increase the production of ethanol to be mixed with gasoline and to be used as a commodity in the chemical industry (Hira & de Oliveira, 2009).

As part of the policy tools used, the state-owned oil company PETROBRAS maintained a stable demand and used strategic reserves to stabilize its supply of ethanol, managing a cross-subsidy between gasoline and ethanol to increase ethanol's attractiveness to consumers (CGEE, 2010).

The Brazilian Development Bank ("BNDES") provided US$ 2.0 billion in low-interest loans to develop infrastructure for the distillation process (Moreira & Goldemberg, 1999). In terms of trade policy, a production quota and export controls for sugar were established (Hira & de Oliveira, 2009). In a short period of time, the country built an extensive distribution network for hydrated alcohol and strengthened its public policies for the industry.

In 1979, during the second wave of the energy crisis, the Brazilian government raised the annual production target of ethanol production to produce about 15 billion liters of ethanol per year (Hira & de Oliveira, 2009). Most importantly, at that time, the government developed productive connections in the domestic economy (Rodriguez, 2006). The government and the automobile industry established a partnership to push for the technological development of vehicles fueled exclusively with sugarcane-based ethanol (Rodriguez, 2006). In 1980 and 1981, changes in international oil prices and a deficiency in price planning led to the loss of competitiveness in ethanol production and created mismatch between supply and its growing demand (Hira & de Oliveira, 2009).

Throughout the 1990s, the ethanol market suffered from structural changes. Subsidies and regulation were gradually removed and new technological standards placed ethanol-exclusive cars at a disadvantage (Moreira & Goldemberg, 1999). The ethanol market, in its different versions, was deregulated, and market-based prices became effective in 1999 (Moreira & Goldemberg, 1999).

Gasoline prices were liberalized in 1998, and the 40 percent tariff quotas for sugar exports were eliminated (Hira & de Oliveira, 2009). In 1993, in order to prevent a collapse of the entire ethanol-production industry in the country, the government set a mandatory blend of 22 percent of anhydrous alcohol and gasoline (Moreira & Goldemberg, 1999). The automobile industry concentrated its research on producing more economic gasoline vehicles, which accounted for 75 percent of sales in 1996, while ethanol-only automobile sales dropped down to less than 1 percent (Moreira & Goldemberg, 1999).

In the 2000s, under the presidency of Lula Da Silva, the Brazilian government decided to reintroduce industrial policies and made ethanol production and exports a priority (da Silva, 2011). But it did so in a new context: when more demand for biofuels arise together with increased concerns over biofuels' environmental and social sustainability (CGEE, 2009). From 2000 onwards, international and domestic factors converged to boost the resurgence of the biofuel industry. In the international arena, rising oil prices and concerns about climate change and the impact of green house gas emissions spurred a renewed interest in biofuel as an alternative to substitute petroleum consumption for transport (CGEE, 2009).

Domestically, ethanol consumption remained steady after the crisis in the 1990s, due the compulsory addition of anhydrous ethanol with gasoline, ranging from 20 percent ("E20") to 25 percent ("E25") and the introduction of flex fuel cars in the domestic market (Kloss, 2011). Flex fuel vehicles were first released in March 2003, and approximately 850,000 flex fuel vehicles were circulating in Brazil by late 2005 (Rodriguez, 2006). From 2003 to 2004, domestic demand for ethanol rose 259 percent, and until 2009, six automobile manufacturers in Brazil produce fifty-two different models (UNICA & APEX, 2009). In 2009, ethanol accounted for 40 percent of Brazil's transportation fuel (UNICA & APEX, 2009), and close to 90 percent of new cars sold in Brazil was flex-fuel (UNICA & APEX, 2009).

## 4.1 POLICIES TO IMPROVE SUSTAINABILITY OF BRAZILIAN ETHANOL INDUSTRY

While in the 1970s and 1980s, the main requirement of the ethanol industry was to maintain a cost 70 percent that of gasoline to be competitive, currently it is important not only to have low prices but also to guarantee the sustainability of the production process to maintain the social license to operate in the domestic market and to participate in the global biofuel market (UNICA, 2011).

Sustainability became a central component of the competitiveness of the ethanol industry in 2000 (Interview with representative of UNICA, 2010). Prompted by external pressure from developed countries, and from increasing domestic concern for economic growth and respect for the environment, sustainability became a must for the biofuel industry to remain competitive (Interview with representative of UNICA, 2010). Social, economic, and environmental standards impacted both the local and international market, increasing the demand for better practices with higher levels of scrutiny and transparency (Interview with representative of UNICA, 2010).

The Brazilian ethanol industry needed to integrate policies to support the environmental sustainability of sugarcane-based ethanol considering its lifetime GHG emissions (Interview with representative of UNICA, 2010). In particular, Brazil needed to define a response to the potential impact on deforestation and biofuel production in sensitive zones (Interview with representative of UNICA, 2010). Most of its responses to these concerns were shared between the state and the private sector, and the Brazilian ethanol industry benefited from domestic policies oriented to make the domestic economy greener (Interview with representative of the Secretary of Environment, 2010).

## 4.2 ETHANOL POLICIES TO INCREASE COMPETITIVENESS AND ENVIRONMENTAL SUSTAINABILITY

During the second term of President Lula Da Silva, ethanol policy was a strategic part of the Brazilian energy goals and a central topic in its foreign policy (da Silva, 2011). This focus was part of a broader understanding of the developmental goals and opportunities for the country, where the production of renewable resources of energy—and in particular, agro-energy—has become a central component of the national development plans.

Ethanol was recognized as an opportunity to strengthen the agricultural sector through the development of a growing agro-energy industry (Ministry of Agriculture, 2006). In terms of energy goals, ethanol production makes an important contribution to Brazilian energy security and autonomy by reducing dependence on oil for transport fuels (Ministry of Agriculture, 2006), but it also makes an important contribution to Brazil's domestic GHG emission savings by partially replacing fossil fuels in both the transport sector and electricity sector thanks to co-generation (Ministério da Ciência e Tecnologia, 2004). These contributions facilitate the country's fulfillment of its commitments as part of the Brazilian climate change policy, and solidify Brazil's position as a global leader in the production and consumption of renewable energy (Brazilian Government, 2008a). Furthermore, the ethanol industry has been recognized as an important contributor to socio-economic development, given its higher labor intensity in comparison with the petrochemical industry (Ratton & Godoy, 2010) and the better conditions offered to workers in comparison with other industries in the agricultural sector.

Even though sustainability issues remain,[14] the Brazilian government, together with the private sector, has made an important effort to demonstrate sustainability improvements in the industry in the international arena and the different policies that have created them.

#### 4.2.1 Policies at the Global Level

At the global level, Brazil has worked toward having a voice in the definition of the international environmental agenda, supporting the introduction of renewable energy use targets in developed and developing countries. In an attempt to build an international

[14] The Brazilian government keeps promoting policies to improve the sustainability of the ethanol industry. It is under discussion that the Forest Code might have an important impact on Sugarcane producers among others.

market for biofuels, the Brazilian government and its private sector, worked on defining an international standard for the intrinsic quality of ethanol. In 2007, Brazil initiated the Tripartite Task Force on Biofuel Standards (which included Brazil, the European Union, and the United States) and the International Biofuels Forum, which works toward harmonizing the standards and codes for the biofuels industry (Tripartite Task Force, 2007). This effort was complemented by negotiations between the International Organization for Standardization, the Global Bioenergy Partnership, and the World Trade Organization (Kloss, 2011).

In addition, during 2007, the European Commission and the European Committee for Standardization—in conjunction with the United States' National Institute of Standards and Technology and Brazil's National Institute of Metrology, Standardization, and Industrial Quality—worked toward finding compatibility for biofuel-related standards in their respective regions (INMETRO, 2012).

In response to arguments from environmental organizations about the potential negative environmental impact of biofuels, the Brazilian government, in conjunction with the private sector represented by the Brazilian Sugarcane Industry Association (UNICA), assumed a twofold strategy. It adopted a defensive position against the risks associated with the introduction of environmental criteria regarding the technical barriers to trade, and it also introduced policies in the domestic realm to increase the sustainability of the production processes.

Brazil had support claims that sustainability criteria might create technical barriers to trade, based on the protected domestic biofuel producers in other developed countries that have grown under heavy state support and displayed serious difficulties competing without subsidies (da Silva, 2011). The Brazilian response to the EPA and RED's sustainability criteria was to emphasize the country's efforts at the international level to influence the definition of "sustainability criteria" that might affect their biofuel production and the prospect of building an international biofuel market.

#### 4.2.2 The Brazilian Response to the EPA Sustainability Criteria

When the EPA began discussing sustainability criteria, the Brazilian Embassy in Washington DC expressed concern from the Brazilian government. The main issues Brazil had was the methodology proposed for calculating the GHG emissions of biofuels, as there was no consensus in the international scientific community about how to calculate the indirect land-use change impact (Kloss, 2011). The Brazilian government requested that the EPA bring together expert scientists from both countries, under part of the scientific cooperation component of the Memorandum of Understanding signed by both countries in 2007 (Kloss, 2011).

Brazilian experts from both the private and public sector actively participated in these consultations conducted by the EPA, focusing particularly on the effects of ILUC (Guardabassi, 2011). In 2010, in response to the EPA proposal to classify biofuels regarding their lifetime GHG emission savings, Brazilian researchers developed a model called the Brazilian Land-Use Model ("BLUM"), which would be integrated with the EPA model (ICONE, nd). The BLUM adjusted the calculations made by the EPA (calling for a 44 percent reduction in emissions of GHG emission) to meet the reality of Brazilian production, so that the balance of emission would be as accurate as possible (ICONE, nd). As a result, the final model found that the GHG emission savings of Brazilian sugarcane-based ethanol was 61 percent, which led to the classification of sugarcane-based ethanol as "advanced" for the purposes of the Renewable Fuel Standard two (RFS-2) and increased the percentage of ethanol that could be exported to the American market (Kloss, 2011).

#### 4.2.3 Brazilian Response to the European Union's Renewable Energy Directive

To address the discussion about ILUC and the implication of the RED, the Brazilian government exerted its influence through multilateral and bilateral bodies. Together with other developing countries interested in exporting biofuels to the EU markets, Brazil created the Brussels Group (Rodriguez, 2006)[15], which worked with the EU Parliament and the EU Commission to discuss the group's concerns about the implementation of measures to address ILUC effects based on controversial scientific evidence. The group also voiced its concerns about the trade implications of imposing sustainability criteria that might become technical barriers to trade (Rodriguez, 2006).

Additionally, the Brazilian Mission in the European Union followed the progress of the discussions and articulated the submission of comments to the public consultations from

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[15] The Brussels group is conformed by Argentina, Brazil, Colombia, Indonesia, Malaysia, Maurice Island, Mozambique, Sierra Leone and Sudan.

the Commission (UNICA & APEX, 2009). In 2009, as part of the bilateral strategy to address the RED, the director of the Department of Energy in the Ministry of Foreign Affairs, André Corrêa do Lago, held meetings with representatives from Directorate General for Transport and Energy (DG-TREN) and the Director of International affairs from Directorate General Environment (Rodriguez, 2006). The Brazilian government maintained its commitment to improving the sustainability of ethanol production and demanded a discussion about the methodology used to measure GHG emission savings (Rodriguez, 2006).

Consistent with the method used in the EPA sustainability criteria, the Brazilian researchers were mobilized to provide sound data to support the differentiation of sugarcane-based ethanol from other biofuels (Interview with policy maker from the Brazilian Ministry of Foreign Affairs, 2010). Most Brazilian efforts to strengthen the domestic and international market for biofuels have been built upon a strong research effort to differentiate Brazilian ethanol from other biofuels to address the doubts that have been raised about the actual benefits of biofuels regarding the mitigation of GHG emissions (Interview with policy maker from the Brazilian Ministry of Foreign Affairs, 2010).

Many domestic universities in Brazil and research centers that specialize in ethanol production have deployed time and energy to support a research-based lobby to argue the comparative benefits of Brazilian ethanol, to provide their estimates for GHG emissions, and to introduce a detailed analysis of production processes to calculate the net GHG emission saving (Interview with researcher from The University of São Paulo, 2010).

Most universities in the country, such as the University of Campinas, University of São Paulo, and Federal University of Rio de Janeiro, have developed research centers specialized in agro- energy, especially in sugar-based energy (APPIC, nd). Their efforts have been directed at generating information to discuss if the ethanol industry can fulfill the requirements of different international sustainability criteria for biofuels, focusing their analyses on the effect of land use change, including the direct and indirect impacts, socio-economics benefits, and the impacts of ethanol production analysis at a regional level[16]. Among these effects, it is important to understand the potential impacts on water availability and quality, the impacts of fertilizers and agro-chemical use alongside biomass production, soil impacts, and the effect of biofuel expansion and loss of biodiversity (Walter et al., 2011).

Part of the concern is that to produce biofuels there are a variety of raw materials, agricultural techniques, production methods, and technologies applied that directly influence the energy balance, and consequently, the balance of the greenhouse gas emission that need to be taken into account to address in the sustainability criteria for the biofuels market (Guardabassi, 2011).

[16] For further information about research projects in agroenergy and ethanol production in Brazilian research centers, see Projetos Cenbio, Centro Nacional De Referência Em Biomassa, http://cenbio.iee.usp.br/projetos.htm#cana (last visited July 1, 2012); IAC Relatórios, Instituto Agronômico [IAC], http://iac.impulsahost.com.br/publicacoes/relatorio_ativ_iac/; Projetos e Publicações, Núcleo Interdisciplinar De Planejamento Energético [NIPE], http://www.nipeunicamp.org.br/site/home.php?pagina=nipeemfoco.php?codigo_pasta=14.

### 4.2.4 Brazilian Responses to the Commission Public Consultations

In the pre-consultation held by the Commission, the Brazilian government contested the introduction of policies to address ILUC impacts as part of the Reducing Emissions from Deforestation and Degradation ("REDD"), arguing there is no agreed scientifically based methodology to calculate GHG emissions from indirect land-use changes caused by any activity, including the production of biofuel feedstock (European Union Commission, 2009c; UNICA, 2009c; Goldemberg & Coelho, 2009).

To address the potential effects of ILUC, the Brazilian government and UNICA stand in favor of a multilateral response (UNICA, 2009c). For them, the best alternative was the definition of guidelines and policy alternatives in the frame of the United Nations Framework Convention for Climate Change (UNFCCC) to deal with the issue of greenhouse gas emissions due to indirect land-use change through the promotion of sustainable management practices in carbon-rich habitats, particularly in developing countries, through the promotion of positive incentives for Reducing Emissions from Deforestation and Degradation ("REDD") and the implementation of national policies that would have an impact on land-use strategies of any given country (Brazilian Government, 2009).

As part of its policy alternatives, Brazil emphasized the need to provide developing countries with financial support, technology, and the building capacity to enhance these countries' ability to reliably estimate changes in forest cover and the associated changes in carbon stock (Brazilian Government, 2009). In addition, UNICA also called on the European Union to recognize the efforts made in some countries, such as Brazil, to establish sound land use management practices and encourage the use of land, which is both available and suitable for crops for biofuels without displacing other crops and sensitive areas (UNICA, 2009).

An alternative to addressing ILUC effects though a multilateral response might benefit developing countries. First, because a multilateral response allows participation in the choice of criteria and methodologies that will measure the impact of ILUC, it reduces the risk of the adoption of unjustified or discriminatory measures and prevent the proliferation of standards and procedures to be followed to meet the sustainability requirements required by importing countries. The higher the harmonization of requirements, the lower the transaction costs for economic agents and the greater the possibility that biofuels will reach the condition of international commodities (Kloss, 2011). Second, the possibility of addressing sustainability criteria in multilateral forums could potentially facilitate the definition of international standards oriented to achieve a better balance between the environmental, social, and economic dimensions of development. This would allow developing countries to manage their resources in favor of their domestic interests (Interview with policy maker from the Ministry of Agriculture, Livestock and Food, 2010).

#### 4.2.5 Bilateral Agreements and South-South Technical Cooperation to Promote a Sustainable Biofuel Production

Part of Brazil's international agenda was to demonstrate that there is a possibility to produce biofuels in a sustainable way in the global south (Interview with policy maker from the Brazilian Agency of Cooperation, 2010). To this end, Brazil has signed numerous agreements for technical cooperation with other developing countries with the aim of increasing the production of biofuels globally, but also to use their biofuels production experience as a tool for south-south cooperation for development (Interview with policy maker from the Brazilian Agency of Cooperation, 2010). Most agreements have included research into alternative raw material for the production of biofuels, as well as academic and scientific exchange. (Interview with policy maker from EMBRAPA Agro energy, 2010). To date, the Department of International Acts of the Ministry of Foreign Affairs ("MRE-DAI") has evidence of more than twenty-two bilateral or multilateral agreements in the energy sector between 2004 and 2008 (Cruz, 2010). Specifically, in 2007, at the India-Brazil- South Africa Dialogue (IBSA) Summit, Brazil, South Africa, and India committed themselves to facilitating technology transfer and to promote the production and consumption of renewable fuels with the goal of establishing a global market for biofuels, particularly ethanol (European Parliament, 2009).[17]

Additionally, in 2007, the United States and Brazil signed a Memorandum of Understanding, which included technical cooperation with countries in the Caribbean to evaluate the feasibility of biofuel production (Kloss, 2011). As part of this objective, the Brazilian National Agricultural and Livestock Research Organization ("EMBRAPA") opened offices in African countries and participated in technical cooperation through projects established by the Brazilian Agency of Cooperation ("ABC") and also supported

[17] Council Directive 2009/30, art. 7a, 2009 O.J. (L 140) 2(a)

and participated in various activities and negotiations of international cooperation in science and development promoted by the Ministry of Science and Technology (Fernandez, 2011).

As part of the Memorandum of Understanding with United States, the Getulio Vargas Foundation ("FGV") was commissioned to carry out feasibility studies for biofuel production in El Salvador, Haiti, and the Dominican Republic (FGV, 2009). The study corresponding to Saint Kitts and Nevis was the responsibility of the Organization of American States (OAS), which was later supplemented by a new study from FGV (Kloss, 2011). The studies were carried out by Brazilian experts in agro-energy in subtropical zones and took into account a complete survey of the physical, social, economic, and regulatory infrastructure that may impact the opportunities for bioenergy production, including economic, social, and environmental criteria (FGV, 2009). Upon completion of the initial phase of activities with the first group of countries, Brazil and the United States decided to expand the scope of cooperation to include five new countries, three from Central America and the Caribbean (Guatemala, Honduras, and Jamaica) and two from Africa (Guinea Bissau and Senegal) (Kloss, 2011).

For each country, the studies considered detailed information about the conditions and requirements for the government and private actors in each country to produce biofuels (FGV, 2009). In the second stage, the studies assumed that government should, based on the recommendations made, elect one or more priority projects so that they could work with multilateral organizations to promote resources for the next phase or articulate efforts with private investments (FGV, 2009). In Africa, studies were conducted in partnership with the United Nations Environment Program (Kloss, 2011). In Senegal, the first African country included in the study, the team of analysts from the FGV identified projects to be implemented in the country, with high profitability and good prospects for replication (Interview with researcher from the Getulio Vargas Foundation, 2010).

Most of the technical cooperation projects included a component of institutional capacity development to help carry out basic research activities to support the industry (Interview with representative from EMBRAPA Agro energy, 2010). These projects also included a technical capacity component to manage environmental sustainability policies, through, for example, transfer of technology to develop agro-ecological zonings to rationalize agricultural activities (Interview with researcher from the Getulio Vargas Foundation, 2010).

## 4.3 ETHANOL POLICIES IN THE DOMESTIC REALM

The most important Brazilian plan for the ethanol industry was the National Agro Energy Plan ("PNA," 2006–2011), which had the purpose to organize and develop a program oriented to guarantee the sustainability and competitiveness of the agro-energy supply chain (Ministry of Agriculture, 2006).

EMBRAPA, a well-respected Brazilian research institution with international renown, launched EMBRAPA Agro energy, which acted to coordinate, execute, and integrate national and international research networks, involving managers and researchers from thirty-seven other units (Ministry of Agriculture, 2006). It also included investment in facilities like laboratories and funding for pilot projects in cooperation with the private sector with the aim of facilitating technological transfer to the different stages of the bioenergy supply chain (Ministry of Agriculture, 2006).

EMBRAPA Agro energy pursues energy, environmental, and socioeconomic objectives. On the one hand, it has to contribute to increase the participation of renewable energy in the national energy balance, while on the other hand the program operates in compliance with the Brazilian environmental policy to support the sustainability of the industry (Ministry of Agriculture, 2006). In particular, it was expected that more sustainable production of ethanol can facilitate the fulfillment of the Brazilian commitment to the Kyoto Protocol and take advantage of the opportunities in the frame of the Clean Development Mechanism to obtain carbon credits (Ministry of Agriculture, 2006). Additionally, it was expected that Agro energy could contribute to create opportunities for the expansion of employment and income generation within the scope of agribusiness, with increased participation of small farmers (Ministry of Agriculture, 2006).

#### 4.3.1 Productivity Improvements

It is widely recognized that the best alternatives to manage the energy balance of biofuels requires efficiency gains in feedstock production and manufacturing processes (IEA, 2010, pag 22). In particular, productivity improvements might diminish biofuel expansion to fulfill a growing demand, and the introduction of renewable energy in the production process could positively affect their energy balance after considering the net impact in their lifecycle production process (UNICA, 2011).

In the case of Brazil, due to the technological developments achieved both on the agricultural and industrial sides, average production yields have grown from 3,000 liters/ha[18]/year (67 GJ/ha/yr.) in the early 1980s to 6,500 liters/ha/year (145 GJ/ha/yr.) in 2005 (Walter et al., 2008).

The growth of sugarcane yields has been mostly due to the development of cane varieties, an effort that also aims to increase the sugar content in the sugarcane (expressed by the total reducing sugars index, or TRS) (Walter et al., 2008). To give an idea of the evolution of sugarcane in the past twenty-five years, the TRS almost doubled and the best practice figures are close to 15 percent of TRS (Walter et al., 2008). In terms of production costs, the largest share of the total feedstock cost reduction was due to the development of new varieties of sugarcane with indirect impacts on the costs of soil preparation, planting, stock maintenance, and land rents (Walter et al., 2008).

The area cultivated in 2008–09 for the sugarcane harvest was 7.8 million ha, which represents 0.9 percent of the national territory (UNICA & Ministry of Agriculture, 2009). It is expected that the expansion of sugarcane production for 2017 will be 6.7 million ha, equivalent to an additional 0.8 percent increase to the national territory (UNICA & Ministry of Agriculture, 2009).

Cogeneration is an important opportunity for sugarcane and ethanol producers, to the extent that it contributes to the autonomy in energy consumption in mills and distilleries

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[18] Hectare (Ha) is a metric unit of area defined as 10,000 square metres (100 m by 100 m), and primarily used in the measurement of land.

and significantly reduces the carbon footprint of ethanol production (Ministry of Agriculture, 2006). Bagasse from the crushing operation can be burned in the mills' boiler, which make the mills self- sufficient in energy and lowers their consumption of diesel in the production process (Goldemberg et al., 2008). Additionally, it is a potential opportunity to supply electricity produced by biomass to the general electric system, making a global contribution to GHG emission savings in the country (Ministry of Agriculture, 2006).

In many cases, the mills have energy surpluses, which can be sold to the general system of electricity (Goldemberg et al., 2008). In fact, in 2004, total power generated was more than 4 GWh during the harvest, or approximately 3 percent of the country's annual power generation capability (Ministry of Agriculture, 2006). In addition, cogeneration from sugarcane bagasse was identified as a possibility for selling carbon credits in the framework of the Clean Development Mechanism (CDM) as part of the Kyoto Protocol (de Souza, 2009).

Additionally, bioelectricity from sugarcane is a particularly interesting option for Brazil because it is a natural complement to hydropower, the main energy resource for electricity generation in the country. The sugarcane-harvesting period, when most biomass is available, coincides with the dry season when hydroelectric power stations are affected by lower levels of water in their reservoirs (UNICA & APEX, 2009).

In 2002, to promote cogeneration and the use of sugarcane bagasse as a renewable energy source for electricity, the government launched the National Program of Incentives for

Alternative Electricity Sources ("PROINFA") (PROINFA, nd). This initiative posits a set of incentives to increase the participation of renewable sources in electricity generation, emphasizing the contribution of biomass, wind, and micro- hydropower (PROINFA, nd). Additionally, the Brazilian National Development Bank ("BNDES") has special financing available for these renewable projects as well as up to 70 percent of capital costs, excluding site acquisition and imported goods and services at the basic national interest rates plus 2 percent of basic spread and up to 1.5 percent of risk spread, although no interest is charged during construction (UNICA & Ministry of Agriculture, 2009).

### 4.3.2 Changes in the Domestic Environmental Regulations

The Brazilian environmental legal framework is deeply rooted in a series of laws, statutes, and environmental management systems generally considered to be quite advanced and relatively strict compared to most other developing countries (Teixeira & Miccolis, 2011). Unfortunately, many of these ambitious policies on paper are very difficult to enforce in practice (Teixeira & Miccolis, 2011).

As part of the legal framework to improve environmental sustainability of sugarcane and ethanol production, the Sugarcane Agro-ecological Zoning Decree and the Green Protocol from the state of São Paulo are remarkable for their direct impact on ethanol production processes.

#### *4.3.2.1 The Sugarcane Agro-ecological zoning*

The Ministry of Agriculture and EMBRAPA, in collaboration with the ethanol production sector, developed the Sugarcane Agro-ecological Zoning Project. This project seeks to provide a framework to rationalize the expansion of sugarcane plantations and foster the production of green ethanol (UNICA & Ministry of Agriculture, 2009). The project consisted of a thorough study of the Brazilian regions' weather and soil that took into account environmental, economic, and social aspects to guide the sustainable expansion of the sugarcane production and investments (ITF, 2010). The orientations provided by the study led to a proposed statute, which the government submitted to the Brazilian congress for discussion on September 17, 2009 (UNICA & Ministry of Agriculture, 2009).

The Sugarcane Agro-ecological Zoning Decree provides incentives for the private sector to foster an environmentally and socially sustainable production process (UNICA & Ministry of Agriculture, 2009). It seeks to protect natural reserves and forestry through prohibition of the construction or expansion of sugarcane farms and production plants in any area of native vegetation, or in the Amazon, Pantanal (containing the Brazilian wetlands), or the Upper Paraguay River Basin (UNICA & Ministry of Agriculture, 2009).

It also offers plantations the alternative to expand to zones with natural conditions for more sustainable production and more efficient irrigation practices. These zones could facilitate mechanized harvesting instead of cane burning and the reutilization of eroded land for new projects (UNICA & Ministry of Agriculture, 2009). Considering the criteria applied in the decree, the current extension of sugarcane plantations, equivalent to 1.5 percent of the Brazilian territory, could be expanded to 7.5 percent, equivalent to 64.7 million hectares (do Amaral, 2010). Although the plan is still a decree and has not yet been passed by The Brazilian Parliament, based on information gathered through interviews with policy makers, the Agro-ecological zoning has shown a high level of efficiency in controlling the investment in protected zones (Sanchez & Godoy, 2010).

The main factor explaining this effectiveness is that the financial sector has included compliance with the zoning to condition granting of credits for production expansion (ECCP, 2003). The National Monetary Council has enforced that decision affecting the private banks, and the Brazilian National Development Bank has pursued the same policy (Interview with representative from the Ministry of Agriculture, Livestock and Food, 2011). Additionally, limiting expansion to protected zones has worked by denying environmental permits in these regions (Teixeira & Miccolis, 2010).

The legislative process to convert the Agro-ecological zoning into law has been conditioned upon a reform discussion about the Brazilian Forest Code, which states that all rural properties must set aside a percentage of land as "legal reserves," where the native vegetation must be preserved under the Forest Code (Goldemberg et al., 2008). This law also determined that the banks of all water bodies (such as rivers, lakes, streams, and springs), as well as steep hillsides and ridges, must also be preserved in Permanent Preservation Areas (Brazilian Government, 2012a). The distance from either side of riverbanks that must be left intact, which varies according to the width of the river, ranges from 30 to 500 meters (Brazilian Government, 2012a).

Currently, the percentage of legal reserve required varies per eco-region in Brazil, from 80 percent in the Amazon, 35 percent in stretches of the Cerrado (within the "Legal Amazon," and 20 percent throughout the rest of the country (Brazilian Government, 2012a). Upon receiving a new land title, landowners are obliged to map and commit to preserving—and recovering in the case of degraded lands—these two parts of their land (Brazilian Government, 2012a). While these legal provisions are extremely difficult to enforce in vast swathes of hard-to-reach lands, especially in the Amazon, they do act as substantial constraints on expanding biofuels in the northern and parts of Midwestern Brazil, where the Legal Amazon' is located (Teixeira & Miccolis, 2010).

According to an assessment by the Luiz de Queiroz College of Agriculture Environmental Program at the University of São Paulo, the average legal reserve in São Paulo cane mills ranges from 8 to 12 percent, which is only half of the 20 percent required by the environmental code for the southeast (Brazilian Government, 2012b). The Luiz de Queiroz College of Agriculture in association with UNICA and the Organization of Sugarcane Planters of the State of São Paulo ("ORPLANA") have been working on a project to install reforestation projects in 1.8 million hectares in São Paulo, which includes lands associated with thirty-three mills (Teixeira & Miccolis, 2010). Moreover, UNICA and ORPLANA are lobbying the federal government to prevent Decree 6.686/2008 from coming into effect (Teixeira & Miccolis, 2010).

The Decree of 6.686/2008 amends and includes provisions in Decree 6514 of 22 July 2008, which regulates for offenses and administrative penalties to the environment and establishes the federal administrative process for investigating these offenses (Brazilian Government, 2008b). This law instituted a 120-day deadline for landowners to register legal reserves occupying 20 percent of their properties or else face fines (Teixeira & Miccolis, 2010).

Changes to the forest code are currently a matter of political discussion in Brazil. In 2012, President Dilma Rouseff vetoed a reform proposed by transversal representatives of landowners in the parliament, which offered amnesty to landowners who violated the standards of biomass preservation set in 1989 and deforested thirty meters of Permanent Preservation Areas on the banks of rivers up to ten feet wide (Brazilian Government, 2012b)

#### 4.3.2.2 Agro-environmental Protocol in the State of São Paulo

Close to 60 percent of the total production of ethanol takes place in the state of São Paulo, one of the most active states in the country in pursuing sustainability criteria to regulate its economic activity and development (UNICA & Ministry of Agriculture, 2009). Environmental objectives for sugarcane ethanol production in São Paulo include the accelerated phase-out of sugarcane crop-burning practices; water conservation and the protection of water bodies; protection of the remaining forests; recovery of riparian areas and biodiversity corridors; minimization of emissions to air, water, and soil; prevention of soil erosion; adequate management of agrochemical use; the enforcement of fair labor practices; and the encouragement of environmental education and public awareness (Guardabassi, 2011). Legislation enacted in 2002 (Law 11,241) regulated agricultural burning practices and restricted burning to 25 percent of mechanized and 13.35 percent of non- mechanized areas (Decree 45,689) (Sao Paulo Government, 2002). Using 2008 as a reference year, the restriction of burning in areas suitable for mechanical harvesting could allow for a reduction in GHG emissions in a volume equivalent to six million tons of carbon dioxide (UNICA & Ministry of Agriculture, 2009). This means that Brazil would avoid annual carbon dioxide emissions equivalent to the emissions from 2.2 million light vehicles (UNICA & Ministry of Agriculture, 2009).

In 2007, the State of São Paulo, in conjunction with the Sugarcane Business Association UNICA, launched the Agro- environmental Protocol of the State, also called the Green Ethanol Protocol (UNICA, 2007). The text of the protocol stipulates a set of measures to be followed, accelerating the legal deadlines for the elimination of sugarcane harvest burning and immediately halting burning practices in any sugarcane harvests located in expansion areas (Sao Paulo Government & UNICA, 2007). It further targets the protection and recovery of riparian forests and water springs in sugarcane farms, controls erosion and content water runoffs, implements water conservation plans, stipulates the proper management of agrochemicals, and encourages reduction in air pollution and solid wastes from industrial processes (ECCP, 2003).

This protocol is a voluntary agreement that specifies a gradual substitution of cane burning by mechanized processes with the aim of contributing to reduce greenhouse gas emission. By 2031, producers should reach the protocol's target of eliminating 100 percent of the cane burning and introduce mechanized harvest (Guardabassi, 2011). A few non-adherent plants are being targeted by environmental inspections and satellite surveillance helping to focus public efforts in control and inspection (Lucon, 2008). From 2000 to 2005, mechanized harvest increased from 25 percent to 35 percent of total production (UNICA, nd). In São Paulo, 146 out of 196 ethanol mills have adhered to the protocol, representing 89 percent of the sugarcane currently processed, and the number of sugarcane suppliers that have adhered the protocol is estimated as 13,000 (Guardabassi, 2011).

The program has demonstrated a high level of participation from the private sector achieving positive results (Lucon, 2008). Giving its adhesion rates, it is expected that the due date for phasing out sugarcane burning previous to harvest in areas where it is easier to introduce mechanical process with declivity lower than 12 percent will change from 2021 to 2014 (Jank et al., 2007). The percentage of harvesting without sugarcane burning in these areas should increase from 30 percent to 70 percent by 2010 (Jank et al., 2007). In turn, in areas that posit more difficulties to stop sugarcane burning with declivity higher than 12 percent, the due date will change from 2031 to 2017, and unburned sugarcane in these areas will be 30 percent rather than 10 percent in 2010 (Jank et al., 2007). In addition to the control of sugarcane burning, the protocol includes mandates for soil conservation, including erosion control and contention of water runoff and the implementation of a technical plan aimed at water resources conservation (Guardabassi, 2011). This includes reusing action and a water quality program, the adoption of good practices for packaging agrochemicals waste, and the adoption of good practices aimed at minimize air pollution and optimize recycle of solid wastes (Lucon, 2008).

# 5 CONCLUSION

With the aim of building a sustainable alternative for fossil fuels, developed countries have imposed sustainability criteria for biofuels production affecting the standards and performance of this industry across developing countries. The main objective declared by

Europe and the United States was to generate the right signals to improve biofuel production systems by creating incentives to bring more and better technology to the market while ensuring that biofuels production is not carried out in areas rich in biodiversity (European Parliament, 2009).

From the Brazilian standpoint, since the 2000s, the private and public sector, aware of the new demand posited by potential importers of ethanol, have recognized environmental sustainability performance as a central part of the ethanol competitiveness and as an aspect that needs to be improved over time to maintain Brazil's position at the national and international market of biofuels. Thus, Brazil has pursued a path toward a more sustainable ethanol production by adopting a series of policies to improve the performance of the industry, even when most of its production is currently oriented to the domestic market (UNICA, 2009c). This process has been mainly an externally driven process, led by the potential opportunity to participate in an international market for biofuels, but also as an initiative led from the Brazilian state main factors driving these efforts have been  the recognition by the government and the private sector of the economic and political benefits of including sustainability as a central component in Brazil's ethanol competitiveness strategy. Sustainability has been identified as a way to contribute to efficiency gains, to increase participation in carbon credit markets, to have a social license to operate with legitimacy in domestic and international markets, and finally, to improve conditions to respond to potential technical barriers to trade that might adopt the form of sustainability criteria.

In institutional terms, Brazil has built a strong policy capacity to carry out initiatives in different realms. The country adapted its Ministry of Foreign Affairs to increase their participation on energy and sustainability topics. Additionally, Brazil strengthened its research capacity to support the differentiation of the Brazilian industry and improvements in productivity together with the enforcement of regulatory frameworks and voluntary schemes to define the rules of the game for the expansion of ethanol production. All of these policies have been developed under the definition of a national plan, which situated ethanol in a strategic role for economic and social development and energy goals for the country.

The Brazilian experience demonstrates the complexities of building a more sustainable practice in biofuel production and the demand for institutional capacity to really achieve a better alternative for fossil fuels. Although sustainability criteria imposed from developed countries might generate the right incentives for producers in the global south, the real capacity to achieve the standards might demand close cooperation between the state and the private sector for the development of a set of institutional arrangements needed to implement the right policies to support an environmentally and socially friendly biofuel production industry.

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# CHAPTER 2

# MAKING ETHANOL AN INTERNATIONAL COMMODITY: CHALLENGES FOR THE BRAZILIAN STATE

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Brazil as a big player in the biofuels market represents an interesting site to explore the process of market formation. With this aim, this paper seeks to analyze Brazil's challenges and difficulties in promoting the idea of making ethanol an international commodity as part of its agro-energy agenda. Based on personal interviews with stakeholders from the public and private sector as well as an analysis of secondary information, the paper identifies, from the perspective of the main stakeholders, the complexities in building a global market, emphasizing the institutional and political dimensions of the market formation process and the main challenges facing the Brazilian government in its efforts to increase participation in a global market of biofuels.

# 1 INTRODUCTION

The biofuel market has been politically constructed, meaning the State, through multiple kind of policy instruments has actively participated in its promotion. During the 2000s, biofuels[19] were seen as a strategic alternative to substitute for petroleum to serve increasing demand for energy in the transport and electricity generation sectors. This interest was driven by the volatility of oil prices and the constant uncertainties about the availability of fossil fuels and their increasing projected costs. Additionally, under the threat of climate change, the introduction of biofuels was seen as a mitigation action for the transport sector, mainly in the developed world, with the aim of substituting fossil fuels for a less pollutant alternative. Finally, biofuels were visualized as an industry that might promote green jobs and a green economy, decoupling economic development and environmental degradation (UNCTAD, 2014).

However, the global evaluation of biofuels as an alternative to substitute oil has changed over time given increasing questions from academics and environmental groups about the environmental and social sustainability of its massive production together with a loss of competitiveness in face of other technological alternatives like electric vehicles. In fact, biofuels today is considered an alternative mainly to replace liquid fossil fuels suitable for

[19] Biofuels is defined by the directress of the International Energy Agency as liquid and gaseous fuels produced from biomass. Bioethanol is an alcohol produced by the biological fermentation of carbohydrates derived from plant material. Pure bioethanol (hydrated ethanol, which has usually about 5 percent water content) can only be used directly in cars especially designed to run it. Dehydrated (anhydrous) bioethanol, on the other hand, is used for blending with gasoline so as, which contains up to 25 percent of bioethanol. In this case, no engine modification is typically needed (UNCTAD, 2014)

planes, marine vessels and other heavy transport modes that cannot be electrified (IEA, 2011).

At a global level, Brazil is a strategic actor in the biofuel market. Given its climatological conditions and its experience in the ethanol industry, Brazil finds itself in a privileged position among developing countries to influence the formation and growth of a potential international biofuel market. Using this position, during the decade of 2000, Brazil decided to play an important role in defining the rules of the game and to establish itself as an agro-energy power. To that end, the country fostered promotion policies, introduced blending targets to build stronger demand, and sought to construct a private-public partnership to conquer domestic and international markets.

At the middle of the 2000s decade, regulatory changes in Brazil and other countries together with supply and demand shifts imposed new conditions for the consolidation of the biofuels market (EPE, 2012). Issues such as the resolution of technical barriers to international trade; socio-economic and environmental sustainability requirements together with certification and generation of international standards affected the development of the biofuels market. Additionally, Brazil experienced an ethanol supply crisis after 2008 as a result of climate conditions and the lack of investment in or renewal of sugar plantations; together with the loss of impetus in the initial measures of developed countries to establish commitments to reduce $CO_2$ emissions through the introduction of biofuels in their transport strategies, these pressures substantially affected the trajectory of growth of this market, raising doubts about its capacity to serve as an alternative to oil in the transportation sector for light vehicles but opening new possibilities in the development of second-generation biofuels and in maritime vehicles and aviation.

Based on interviews with Brazilian experts, public officials and academics that had and have a strategic role in the industry, this paper describes the role of the state in building an international biofuel market[20]. The emphasis of this study will be placed on understanding the participation of the public sector, which, through different types of interventions, has been able to mold the development of the industry and defined the institutional structure that govern the market, as well as the main domestic and international constraints that the Brazilian state has faced in this process.

The first part of this document will discuss the role of the state as promoter of economic growth through the revision of Latin American development strategies over time, and current debates about whether states are powerless in a globalized economy. In a second section, I analyze the characteristics of the biofuel market, the principal triggering factors for its emergence, the main expectations, and the participation of Brazil. In a third section, I will analyze the main challenges associated with the creation of the international biofuel market and the position adopted by the Brazilian state, before presenting some preliminary conclusions.

[20] The content of this paper is based on personal interviews with stakeholders of the Brazilian ethanol industry conducted in Brazil in 2011 and the analysis of secondary information.

# 2 DIFFERENT ROLES FOR THE STATE UNDER DIFFERENT DEVELOPMENTAL MODELS

Latin America has experienced different developmental models since the 1930s onwards with different dominant theoretical approaches to economic development providing theoretical support. The postwar economic regime, defined as embedded liberalism, opened the possibility in most developed and developing countries for a successful wave of state intervention and the recognition of economic policy as a powerful tool to promote industrialization (Bresser-Pereira, Maraval & Przeworski, 1993). During that period, the dominant economic approach was Keynesian, which facilitated and provided a favorable context to state intervention and explicitly pursued the objective of industrialization and full employment. At the international level the objectives were the development of a system of cooperative liberal multilateralism with a strong system of international monetary regulation and strict control over capital movements.

Following the great depression in the 1930s, Latin American policy makers turned inward to promote internal sources of economic growth. Instead of relying on the international economy as engine of growth, import substitution industrialization (ISI) policies sought to develop industries in a protected environment. The goal was to create industries capable of producing substitutes for imports and mastering industrial production, with the final aim of developing an endogenous capacity of technological change. The policy tools during the ISI period were oriented on the one hand toward developing an industrial base in the domestic economy, and on the other hand toward controlling international trade in favor of domestic producers. During this period, the state assumed a relevant role in the economy through state owned enterprises (SOEs) in sectors defined as key promoters of growth like heavy industries, energy, minerals, steel, etc.; and in the provision of services considered key for industrial performance. To protect domestic producers from external competition and facilitate the development of infant industries, the state introduced multiple exchange rates to favor exports over imports and to facilitate imports of capital goods to spur the industrialization of the economy. At the same time, the state imposed tariff barriers with the aim of protecting domestic producers of manufactured goods from competition in their initial stage of development under the argument of infant industries and implemented subsidies to support domestic production (Franko, 2007).

The economic crisis of the 1980´s hit Latin America hard (Bresser-Pereira, 2009). In the international realm, the development of financial markets and multinationalization of firms engendered a movement in favor of the liberalization of capital movements, offering unprecedented borrowing opportunities for developing countries, where foreign banks were suited to finance balance of payment deficits in the entire region (Hirschman, 1986). As a result, in the 1980s the region faced the worst economic crisis in its history, a crisis defined by stagnation and high rates of inflation (Bresser-Pereira et al., 1993), where incomes fell everywhere, and unemployment rose to unprecedented levels, especially in the more industrialized countries such as Brazil and Argentina (Hirschman, 1986).

Much as the crisis in the global economy in the 1930s led to the adoption of developmentalist economic policies where autarkic industrialization led by the state seemed to offer a panacea, the expansion of the international financial market and multinational corporations and the debt crisis of the 1980s signaled the end of developmentalism and the beginning of the neoliberal period in Latin America (Gibson, 1997). The implementation of neoliberal reforms in Latin America was a critical juncture in the path of development in the region (Weyland, 2004). The implementation of a neoliberal model in Latin America led to the transformation of the economic structure in the region, producing a new balance between the state and the market. The new economic approach to development in the ‘80s posited that getting prices right and relying exclusively on markets without the interference of the state would bring an efficient reallocation of resources, economic stability and growth (Bresser-Pereira et al., 1993; Gereffy, 2001; Gyynne, 2004; CEPAL, 2007).

The transformation of the state during this time meant cutbacks in state spending and focusing resources accompanied by tight fiscal discipline and tax reforms together with the implementation of a series of pro-business and market led-growth policies. The policies implemented went far beyond the stabilization after the economic crisis and moved much toward structural change (Stalling, 2002). Most economies were opened adopting a uniform tariff rate, most State Owned Enterprises (SOEs) were privatized and social services like education and health were decentralized and privatized as well. In addition, different legal and juridical policies were implemented to enhance and protect property rights, along with reforms to make the labor market more flexible (Grugel & Riggirozzi, 2009). Under a neoliberal paradigm, there was no conceptual space for an active role of the state in maintaining and expanding the private sector’s dynamism (Block, 2008).

However, after the economic crisis in 1998, most countries in the region adopted a more pragmatic approach of neoliberal policies (Arbix & Scott, 2010). This new model of state involvement in the economy is built upon the successes and failures of previous developmental models and paths of social and political changes occurred in the last years.

To characterize this new model, Glauco Arbix (2010) argues that as a legacy of the past period, a new developmental model in Latin America faces new challenges in comparison to previous experiences because of fundamental changes in the sociopolitical and economic context in the region. This new paradigm deals with 1) a more decentralized state both politically and administratively, 2) a new state-private sector relationship, which is more market-adjusting than market-directing, 3) the consolidation of democratic systems in the region, 4) the social demand for pursuing both objectives, economic growth and social inclusion, and 5) a context of open economies and market-friendly environment imposed by the neoliberal reforms.

In a context of open economies and globalization, authors like Block and O'Riain used the concept of developmental network state ("DNS") to characterize a new developmental model among developed countries to improve the productivity of a nation's scientists and engineers with the final aim of supporting a growth strategy based on innovation (O´Riain, 2007).

The DNS plays four overlapping tasks - targeted resourcing, opening windows, brokering, and facilitation. Targeted resourcing involves government officials, with the collaboration of the private sector, identifying innovation that might deserve support. Opening windows seeks to facilitate an appropriate environment to provide fertilizer, to help new ideas grow. Brokering encompasses two overlapping dimensions—technological brokering and business brokering. And finally facilitation refers to joint efforts with the private sector to develop strategies to overcome institutional, technical and economic barriers to technology development (Block, 2008).

Weiss emphasizes the relevance of the state as facilitator and catalysts of national and regional networks to foster the internationalization of their economies (Weiss, 2003). For this purpose, new state capacities are redefined as collaboration building, through engaging others—states, corporations and business associations—to form cooperative agreements and 'consortia' for action on various issues and different strategies to build partnerships of government and business to pursue shared objectives (Weiss, 2003). In such cases, the state's effectiveness in coordinating more complex industrial upgrading in the context of increasing openness has come to rely more heavily on a governance structure involving intense policy dialogue and partnering with the private sector, and on the coordination of inter-firm networks for product development (Weiss, 2010)

Brazil's strategies in pursuing the development of an international market of biofuels are a good example of this literature's approach. In particular, the analysis of the Brazilian experience raises new questions and highlights the main challenges that developing countries may face in pursuing policies to facilitate the internationalization of their products.

# 3 INTERNATIONAL BIOFUEL MARKET, TRIGGERS AND EXPECTATIONS IN THE 2000'S

The international biofuel market is a relatively small market if one considers the size of the energy market as a whole. In 2012, it represented close to 2.5% of global transport fuels (UNCTAD, 2014). Nevertheless, in the last decade the biofuel market has experienced a substantial growth, increasing global production by more than 100% from 2006 to 2013[21]. In 2006 Brazil was the largest producer of ethanol with a total participation of nearly 36% of the global market, followed by the United States and the European Union. Brazil produces ethanol from sugarcane. Its total domestic demand in 2012 was 19 bnl, which is projected to increase (UNCTAD, 2014). In turn, the United States mainly produces ethanol from corn and biofuels, accounting for roughly 7.1% of total transport fuel consumption by 2012 (UNCTAD, 2014). Brazil and the United States largely dominate the ethanol industry at the global level.

During the economic crisis of 2001, many countries across the world initiated the implementation of policies promoting the clean energy industry. An economic sector where there is a strong participation of the State as promoter, regulator and even producer across the world (Harvey & Pilgrim, 2010).

To promote biofuel consumption, the primary tool has been the establishment of required percentages of mixtures of gasoline and diesel, along with setting sustainability standards for the transportation sector like in the EU and the UK, among other countries (Harvey &

[21] World production of bioethanol from sugar cane, maize and sugar beet increased from less than 39 billion liters in 2006 to over 85 billion liters (bnl) in 2012 (UNCTAD, 2014)

Pilgrim, 2010). With respect to supply, countries have used policies such as soft loans and the development of innovation systems to strengthen competition in domestic industries. At the same time, developed countries have implemented trade policies using ancillary barriers and sustainability standards to protect their domestic industries (Calfucoy, 2012).

The major biofuels mandates, together with some estimates of what consumption will look like in 2020, translate into major drivers of an estimated 60 billion gallons of global biofuels demand — without considering the demand from aviation, or mandates in place in countries such as Canada, Australia, or throughout Southeast Asia (Biofuelsdigest, 2011).

In addition to the interest of different states in promoting the clean energy industry, the international discussion about climate change — particularly in the context of the entering into force of the Kyoto protocol of 2005[22], in which developed countries (identified as Annex 1 countries) signed commitments to reduce emissions by 2020 — was also an important driver of the biofuel industry, since expanded use of biofuels was understood as a key mitigation measure to diminish greenhouse gases in the transportation sector[23].

Land, road and rail transport contributes to around 16% of global GHG emissions (UNCTAD, 2014). It is expected that fossil fuels [would] probably remain dominant in the future fuel mix, with a projected continuing share of about 80% of total primary energy supply between 2004 and 2030 in the IEA World Energy Outlook 2006 reference scenario

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[22] The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions.

[23] European Climate Change Program, *Second European Climate Change Program Progress Report.* Retrieved from: http://ec.europa.eu/clima/policies/eccp/documentation_en.htm, (last visited June 2012).

(IEA, 2007). In the coming twenty-five years, in the absence of any corrective measures, the use of gasoline and diesel for road transport will double, creating an enormous challenge to achieving climate-change goals (Soimakallio, Sampo, Kati & Koponen, 2011). In this scenario, by 2050, biofuel could provide 27% of total transport fuel and contribute to the replacement of diesel, kerosene and jet fuel. Biofuels could avoid around 2.1 gigatonnes (Gt) of $CO_2$ emissions per year when produced sustainably (IEA, 2011).

According to these expectations, at the start of 2000, the European Union launched the European Climate Change Program to evaluate alternatives for confronting climate change[24]. In 2003, the European Parliament, together with the European Union Council presented a Renewable Energy Directive setting a target of 2% blending of biofuels and gasoline or diesel consumed in all country members from 2006 onwards. For 2011, the target of mixture was 5,75% (EPE, 2008). In 2007, the European Commission presented the Road Map, setting a mandatory target of 20% for renewable energy's share of energy consumption in the EU by 2020 and a mandatory minimum target of 10% for biofuels. Besides the EU, the United States, Brazil and countries in Asia have blending mandates that drive global demand (Biofuelsdigest, 2011), and promotion policies to foster the local production of ethanol.

In 2005, through the “Energy Policy Act”, the USA set consumption targets until 2012 together with subsidies to producers that included US$0.51 for each part of ethanol added to gasoline (EUA, 2007). Afterwards, President Bush launched the “Energy Independence and Security Act of 2007” in which included a more ambitious target of reducing by 20%

[24] For more information see: http://ec.europa.eu/energy/renewables/targets_en.htm

the consumption of gasoline through expanded consumption of biofuels (EUA, 2007). Brazil has a blending mandate reaching the 15-20 percent range by 2020-2022 and India has a 20 percent ethanol mandate in place for 2017 (Biofuelsdigest, 2011). In turn, Japan, in 2003, included a blending target of 3% (E-3) in an experimental form, and planned a target of 10% by 2012 (EPE, 2008).

# 4 THE PARTICIPATION OF BRAZIL AT THE GLOBAL BIOFUEL MARKET

At the outset of the international biofuel market, at the start of the 2000s, Brazil was in a leadership position due to its participation in the global sugar market and its long experience in producing and commercializing ethanol in its domestic transport sector (EPE, 2008). Brazil is the global leader in the production and consumption of sugarcane-based ethanol (BNDES, 2008). It produces two types of ethanol: hydrous and anhydrous. The former is used to power vehicles equipped with pure ethanol or flex-fuel engines, while the latter is mixed with gasoline to reduce petroleum consumption (BNDES, 2008). Over the last thirty years, ethanol has enhanced its role in the domestic energy mix (BNDES, 2008). In 2013, ethanol met about 23 percent of Brazil's road transport fuel demand (IEA, 2010). To reach this level, Brazil took advantage of its natural resources, including its ideal location in the sub-tropical zone to produce sugarcane and the development of its domestic industry around the agro-energy sector.

Brazil has successfully taken the lead in the generation and implementation of modern, tropical agriculture technology and has developed a robust agro-industry with the conditions to be competitive internationally (Brazilian Government, 2006). In addition its favorable conditions for biofuel production (including weather, rainfall, land availability, and work force), Brazil has taken advantage of its long-term experience with sugarcane production (Brazilian Government, 2006). It has also promoted technological developments, productivity improvements, and an institutional capacity to support the development of the sugarcane and ethanol industry through the implementation of public policies (Calfucoy, 2012).

Participants in the Brazilian industry expected, among other things, to be able to further the development of the ethanol industry through greater industrialization and technological developments that would be much more ambitious than just the export of anhydrous ethanol. They hoped to bolster the development of second generation ethanol industry and to consider the future of the development of biorefineries—a paradigm shift in that it would be empowering a green chemical industry ("sugar chemistry") based on biotechnology like that of the petro-chemical industry (Interview with representative of BNDES, 2010). Additionally, given the level of development of Brazil's sugar and ethanol industries, the country's interests in promoting global production of ethanol not only included the export of the final product, but also participation at a global level in the industry's whole value chain, including the production of technologies and equipment (Rodriguez, 2011).

# 5 THE BRAZILIAN STATE AND THE NEW ETHANOL PROMOTION POLICIES

In the first administration of Lula da Silva in Brazil, the government included as part of its development strategy the idea of revitalizing the country's agro-energy sector; ethanol was strategically central to the pursuit of this objective (Da Silva, 2010). The availability of entrepreneurs with experience in ethanol production, the technological development reached, and the institutional capacity already installed in the country for the development of the industry, were recognized as potential advantages in order to give the sugar and ethanol industries a new push. In this sense, the goal was to make Brazil a strategic player in the world's energy market and specifically in the biofuels market, assuming leadership in setting the rules of the game in this process of market formation (Da Silva, 2010).

In 2003 the Government began to revive the PROALCOOL Programme. Since the beginning of the industry the ethanol industry has transited from strong state control from the beginning of the PROALCOOL program to gradual liberalization by the end of the 1990s. From 1990 to 2009, Belik & Vian (2003) has characterized the ethanol market as a competitive oligopoly without price control, regulations, incentives or coordination from the State. After that period, new institutional arrangements governed the ethanol market; this could be characterized as a post-regulatory period, where public-private collaboration emerged with the aim of fostering the internationalization and strengthening of the domestic market (Tonin & Tonin, 2014).

The new policies included a tax reduction on bioethanol-powered car manufacturers and subsidies for purchasers of new bioethanol cars. Credits for the sugar industry were also introduced to cover storage costs and to ensure future supply (Dufey, Ferreira, & Togeiro de Almeida, 2007). Between 2002 and 2006, the National Development Bank of Brazil (BNDES), the country's principal credit agency, increased disbursements related to the ethanol industry by 241.8% (Averbug, 2007). At the same time, foreign financing — including as part of Germany's decision to purchase carbon credits as part of its Kyoto Protocol commitments — helped Brazil subsidize taxi drivers and car-for-hire companies by 1,000 reais per vehicle on the first 100,000 vehicles sold with Flex-fuel technology (Dufey et al., 2007).

The commercialization of flex fuel[25] cars began in March 2003 and has grown substantially since then[26] (EPE, 2008). In 2003, flex fuel cars made up 4% of total car sales, while in 2009 that number reached 95.4%. In 2010, close to 40% of the total of small vehicles had flex-fuel technology (Souza Ferrés, 2010). In 2003 the development of this technology, along with a period of vigorous economic growth in the country, and a growing automobile industry, made the expansion of the ethanol industry viable in a way that it never had been before. Between 2004 and 2007, ethanol production in Brazil more than doubled, rising from 13 billion liters to 27 billion liters (interview with representative of BNDES, 2010). As a result of the penetration of this technology, the demand for gasoline decoupled from GPD growth, replacing the expected growth in gasoline consumption by a sustained increase in the use of ethanol (Souza Ferrés, 2010).

As a consequence of this expansion, the institutional apparatus of Brazil responded in vigorously, creating departments dedicated to biofuels in different ministries and agencies. In 2007, the BNDES created a biofuels division, independent of the Department of Agro-industry, which had traditionally dealt with the issue, including ethanol, biodiesel and other advanced fuels (Interview with representative of BNDES, 2010).

[25] The possibility that flex-fuel cars offer in substituting the use of gasoline and ethanol is very important in this stage of the industry's development. In the 80s, when the use of ethanol cars began to massify, users faced a shortage crisis that hindered confidence on ethanol supply and devaluated ethanol cars. Therefore, having the possibility of substituting easily from gasoline to ethanol with the flex fuel technology facilitated the penetration of ethanol and the massification of these cars

[26] The proportion of flex-fuel cars increased from 3% in 2003, to 22% in 2004, 53% in 2005, 82% in 2006 and 91,3% 2007.

International cooperation in the area of agriculture, including cooperation in the development of the biofuel industry, was treated from a technical perspective as part of the tasks of the Brazilian Cooperation Agency (ABC). This agency coordinated the projects that came from sectorial ministries, later creating a biofuels and energy unit as part of the Ministry of Foreign Affairs. This pattern demonstrates how the country has increasingly prioritized biofuels and energy as part of its foreign affairs agenda (interview with representative of ABC, 2010). Similarly, EMBRAPA, the Brazilian National Research Agency, launched a branch specifically dedicated to agro-energy with the aim of strengthening research in this sector — but also with the aim of fostering South-South cooperation and technological transfer with countries located in the global south with the potential of building a biofuels industry (Interview with representative of EMBRAPA, 2010).

Regarding the public-private partnership in the ethanol market, the process implied a high level of coordination between the state and the private sector, however, it is important to notice that the Brazilian state led the efforts to facilitate the internationalization of ethanol. Between 2000 and 2010, both government and private sectors worked to consolidate an international market by participating in formal and informal negotiations in the hope of establishing rules for the operation of this market at the global level. Among these rules were the characterization and standardization of biofuels to encourage their commercialization, the development of a normative framework to regulate commerce, and strategies to confront trade barriers from countries with potentially high demand.

The Sugar Producers` Association` UNICA worked in conjunction with government to differentiate Brazilian ethanol from other developing countries' producers, hoping to highlight their progress on environmental and social practices through international marketing strategies, and through academic studies to validate the leadership position of the industry and the country in the world market (Interview with representative of UNICA, 2010).

Informal coordination between the producers' association and representatives from the Ministry of Foreign Affairs, the Ministry of Agriculture as well as with the Brazilian Agency of Export Promotion, with whom there was a formal cooperation agreement, allowed the government to participate in all the spheres and institutions where they might influence standards governing ethanol production and commercialization (Calfucoy, 2012).

# 6 MAJOR CHALLENGES TO THE CREATION PROCESS OF AN INTERNATIONAL BIOFUEL MARKET

A few years into the new cycle of Brazilian ethanol under President Lula, the national and global biofuel context and Brazil's ambitions for this market have changed. As part of the challenges observed based on the interviews to the stakeholders involved in the process, I highlight the complexities in building a global market from the standpoint of a developing country like Brazil.

First, the Brazilian state faced difficulties in governing the domestic market. Domestic shortages of ethanol linked to climatological conditions, lack of regulation in a key market and the non-expected result of the international economic crisis questioned the capacity of Brazil to guarantee a stable supply of ethanol for the domestic and international market.

Second, the state failed to articulate multiple domestic interests in conflict regarding the role that ethanol as fuel should play in the transport sector in substitution for oil.

At the international level, the State together with the private sector faced difficulties in influencing on governance structures for the ethanol market at the international level. In particular, there were important difficulties in building an international governance system to operate the biofuels market and to consolidate a global biofuel supply. Finally, the ethanol international market was hit by a slowdown of the demand building processes. Countries stopped the implementation of blending targets, and new standards and requirements for the international trade of ethanol were posited by the developed world.

## 6.1 Governing the domestic market

### 6.1.1 The Unexpected Supply Crisis; the Brazilian Ethanol after 2008

The ethanol industry's internationalization strategies changed their emphasis in 2008, when the industry began a period of contraction. This affected the ethanol supply at the local level and kept exports at just the point required to fulfill contracts signed earlier, forcing Brazil to import ethanol from the United States and Uruguay to satisfy domestic demand (EPE, 2008). From the perspective of the Sugar Producers Association and representatives from the Brazilian Research Agency, this crisis called into question the capacity of the industry to guarantee the supply and lowered expectations of increasing national production to consolidate an international-level market. The vision of ethanol's expansion to foreign markets predicted in the first half of the decade was frustrated.

According to Jank (2011), from 2000 to 2008 the production of sugarcane rose approximately 10% per year, because of the entry of new plants on the market. From 2005 about 20 plants per year started producing ethanol, a phenomenon due to the abundance of cheap capital for investment and the ambitious prospect for the biofuels market which led to the entry of new companies without experience in production and increased the number of traditional companies.

With the industry's initial push forward at the beginning of the 2000s, businesses that had invested in expansion faced liquidity problems during the economic crisis of 2008. The ethanol industry is highly capital-intensive, and depends on narrow profit margins, making it highly susceptible to financing problems. The crisis of 2008 brought financial difficulties for approximately 30% of the plants of the South Centre, which faced financial and corporate restructuring (EPE, 2008).

The new investments during and after the crisis were characterized by the acquisition of companies already installed and in financial trouble (Tonis & Tonis, 2014), making it difficult to maintain the level of productivity exhibited in the first part of the decade of 2000 (Interview with representative of EMBRAPA, 2010). Given the industry's production structure, sugarcane can only be cut five times; the sixth time it must be renewed. It was this renewal process that did not occur, as it should have. Production had risen to 86 tons per hectare at the start of 2000, but fell to 68 in 2010 as a result of the lack of investment in renewing the sugarcane fields. Moreover, according to Jank (2011), since 2005 the cost of production increased by approximately 40%, because of changes in labor costs and the introduction of mechanization to collect sugarcane, discouraging new investments.

At the same time, in an anti-cyclical measure during the 2008 crisis, the government expanded credit and lowered taxes on cars, positively affecting ethanol demand (Interview with representative of EPE, 2010) and inciting an even more severe mismatch between supply and demand of ethanol, exacerbated by climate problems occurred in the 2009-10 and 2010-11 harvests (Tonis & Tonis, 2014)

Due to these factors, in 2011-12 Brazil played the unexpected role of ethanol importer. According to The Sugarcane Producers Association (2012), from April to December 2011, approximately 705,000 m3 were imported to the South Central region and 421 000 m3 to the Northeast region, allowing a significant increase in supply in the domestic anhydrous ethanol market.

To satisfy domestic demand in the short run, the government took various regulatory measures. The National Association of Oil, (ANP) through the resolution of February 9th 2011 (ANP, 2011), amended the specifications of anhydrous ethanol, changing the quality standards for the product to be marketed in Brazil, to facilitate imports of American anhydrous ethanol in periods of shortage, ensuring the supply of this product to meet the current mixture target.

In addition to this change, the state of São Paulo, by decree n ° 57395 of October 4th, 2011, offered tax flexibilities for imported ethanol, and the Ministry of Agriculture in October 2011 amended the blending target of anhydrous ethanol in gasoline to 20%, without setting an specific date for a return to the old rate of 25% (IEA, 2012).

Finally, in September 2012, the government placed the ethanol market under control of the National Agency of Oil, shifting the characterization of ethanol from an agricultural good to recognizing it as fuel. Under this new regime, this institution assumed the responsibility of ensuring the quality specifications of ethanol, giving predictability to the supply and stimulating stockpiling by suppliers and distributors agents, in order to guarantee stock for the off-season.

To fulfill this mandate, the regulator agency now responsible for the ethanol market introduced a Regulatory Model for the Bioenergy Sector (Resolution 67 of the ANP of 09 December 2011 (ANP, 2011)) by which the responsibility for the security of supply would be shared between producers and distributors of anhydrous ethanol, establishing that all agents have the responsibility to publish regular reports informing about their stocks. This resolution sought to change the market by reinforcing long-term supply contracts between producers and distributors of ethanol under the supervision of the government.

Additionally, the regulation included sanctions for distributors. Any distributor that fails to reach the set quota of ethanol computed from sales during the same period last year would not receive approval to acquire gasoline. Additionally, the new rules opened the possibility of importing ethanol from refineries and petrochemical plants to guarantee national supply (ANP, 2011).

According to EMBRAPA, by 2008, Brazil did not have a domestic plan in place to face the increase in the demand for ethanol as a consequence of increased demand for flex fuel cars that came as Brazil's base of cars expanded dramatically during the period of economic expansion (Interview with representative of EMBRAPA, 2010). At the same time, the expansion of the supply of ethanol at the start of 2000, bolstered by international factors, the adoption of flex fuel cars and the increase national GDP, accompanied by a simultaneous rise in the price of sugar, brought down the level of ethanol production for the domestic market (Interview with representative of BNDES, 2010).

Employees at the Business for Energy Research (EPE in Portuguese) hope that by 2015 it will be possible to attain the production levels that existed before 2010, thereby satisfying all domestic demand once again. The levels of investment required to achieve this goal are much higher than the investment recorded between 2005 and 2010. The EPE projects that at least 10 new annual plants will be necessary to satisfy increasing demand, which would be much higher than the investment rate seen in the industry in general over the last decade.

### 6.1.2 The Oil Industry's Interests, and Coordination Failures, Difficulties in Changing the Energy Mix

The contradictions and conflicts of interests that exist at a global level in the development of alternatives to fossil fuels within the energy sector can also be seen within Brazil. Doubtless, these tensions have influenced the biofuel industry's capacity to reach a position of greater leadership within the global market. Despite the support expressed by the Brazilian government for the development of a biofuel market, the different logics and interest within the Brazilian government affect the ethanol market, sometimes pushing in different directions.

Despite conflicts in the implementation of policies to support the domestic and international market of ethanol within Brazil, during Lula's government a high level of coordination among ministries and the private sector prevailed, pushing to increase the productivity and sustainability of the industry (Interview with representative of Ministry of Agriculture, 2010). Moreover, in this period the federal and national state governments cooperated, helped by coordination from the Presidency (Calfucoy, 2012). In turn, states like Sao Paulo initiated policies to regulate the industry, facilitating the upgrade of refinery practices that would later be adopted by the national government (Interview with representative from the Sao Paulo government, 2010). This level of coordination changed over time, however, and by 2011, when the interviews for this study were conducted, most of the interviewees described a weakening in the relationships and a halt to the formal and informal meetings conducted from the Presidency to coordinate the ethanol promotion policies.

In addition to the changes in presidential administrations when President Rousseff succeeded Lula, there was a major shift in the priorities assigned to fossil fuels, in particular to oil and the National Brazilian Petroleum Firm (PETROBRAS). In Brazil, oil production at the national level continues to be concentrated on PETROBRAS, which controls 96% of the refineries in the country (Souza Ferrés, 2010). Ethanol production, by contrast, is being developed competitively among 400 producers of different sizes. Despite the fact that they can depend on the sugar industry's high level of influence on the country's political economy, the political weight of these producers is not comparable to PETROBRAS' reach and its ability to lobby Brazil's international policymakers (Rodriguez, 2011). This is how the Brazilian government maintains control over prices of oil derivatives, giving gasoline an advantage over ethanol which has a value that fluctuates over a range of prices and is generally subsidized by PETROBRAS.

To be competitive, ethanol must maintain its prices at about 70% of the price of gasoline, and its price must be established by the fluctuations of the market. In this way, an artificial rise or fall in oil prices may fulfill political and economic objectives, like inflation control, but it has important effects on the biofuels market. Particularly in 2004, increased international oil prices were not reflected in the domestic market — at the expense of PETROBRAS, which subsidized the import price according to a range of prices established by the government (Souza Ferrés, 2010).

At the same time, in 2007 Brazil informed the public of the discovery of newfound oil reserves along the country's coasts in deposits in the pre-salt layer (PRESAL). These reserves are predicted to easily overtake projections for the country's demand in the coming years. This positions Brazil as a strategic player in the international energy market. The country has already developed a value-chain associated with the oil industry, with refinery systems controlled by the state through PETROBRAS and the capacity to maintain and strengthen the petro-chemical industry.

## 6.2 Governance structures at the international level

### 6.2.1 Difficulties in Building an International Governance System to Operate the Biofuels Market

The ethanol industry is confined within two highly sophisticated, politically relevant markets. On the one hand, the energy sector — in particular the fossil fuels market — is an oligopoly, and profits from a strategic position in world geopolitics. Fuel is highly regulated in most countries; it counts on different systems for prices control, with regulations to guarantee supply. In most countries, fossil fuels are subsidized, to make their consumption more affordable for the population. On other hand, agricultural goods are sensitive to concerns about food security and tend to be highly protected, especially in developed countries. Ethanol, being a biofuel, is still defined as an agricultural good by the

WTO, and is therefore subject to protectionist measures, especially in the European Community.

According to a representative of the Energy Department of Brazil's Ministry of Foreign Affairs, one important problem for consolidating this market at the international level is that no multilateral institutional framework exists to deal with energy issues at the global level. Without such a framework, it is difficult to determine standards and requirements for biofuels to operate as an alternative to fossil fuels, or to discuss the multiple technical and commercial barriers that currently exist for its global trade.

At this time no formal forum exists within the United Nations that would allow countries to discuss energy issues, in the kind of multilateral way offered by the FAO as a platform for the discussion of food and agricultural issues. Conflicts related to international trade can be resolved through litigation before the WTO, but energy issues are outside of the WTO jurisdiction (Interview with representative of the Ministry of Agriculture, 2010). Therefore there is no governance architecture, defined as an overarching systems of institutions in a given issue area, including formal and informal principles, norms, rules, organizations, decision-making procedures, and other forms of structural arrangements (Bastos Lima & Gupta, 2013). In technical terms, the biofuels market has faced disagreements and slowness in the standardization process and in the formulation of norms to regulate international trade or trade barriers to imports in countries with greater potential demand.

Brazil has been an active promoter of multilateral initiatives to regulate the biofuels market at the global level. Indeed, the Brazilian government and its private sector, worked on defining an international standard for the intrinsic quality of ethanol. In 2007, Brazil initiated the Tripartite Task Force on Biofuel Standards (which included Brazil, the European Union, and the United States) and the International Biofuels Forum, which works to harmonize standards and codes for the biofuels industry (Calfucoy, 2012). This effort was complemented by negotiations between the International Organization for Standardization, the Global Bioenergy Partnership, and the World Trade Organization (Calfucoy, 2012). In addition, during 2007, the European Commission and the European Committee for Standardization—in conjunction with the United States' National Institute of Standards and Technology and Brazil's National Institute of Metrology, Standardization, and Industrial Quality—worked toward finding compatibility for biofuel-related standards in their respective regions (Calfucoy, 2012).

To date, there are no specific codes for bioethanol in international trade nomenclature. Until recently, individual trade codes used by the EU and the United States include biofuels as well as other products, so trade volumes and values were estimated (Agrochart, 2013). This lack of classification and standardization of the product opened spaces for controversies in the global trade regime. As an example, the EU has increased its anti-dumping policy, seeking to control standards of production and protect their domestic producers (UNCTAD, 2014). From 2009 to 2012, most of the bioethanol shipped to the EU was exported as a chemical product, subject to a tariff of 6.5 percent of the customs value. In October 2011, the EU Customs Code Committee approved a proposal by the Commission to classify ethanol and gasoline blends with an ethanol content of 70 percent or more as denatured ethanol to avoid the imports of this product as chemicals. As a result, the tariff was increased to approximately €102/m3, about three times the previous import duty of €32/m3 (Agrochart, 2013)

### 6.2.2 South-South Cooperation to Make a Market with Multiple Suppliers

The creation of a global biofuel market requires the consolidation of a supply sufficiently ample to guarantee security during shortages. Without this kind of trust, consumers are less likely to assume the risks associated with a change in their patterns of energy consumption. To date, biofuels production is very concentrated in Brazil and the United States, which inhibits the creation of a more dynamic international market.

The demand for ethanol in a global market may vary depending on whether ethanol is used as an additive of 5% or 10% with the goal of contributing to the octane, improving combustion and reducing emissions; or whether it is used as a total substitute to fossil fuels in the transportation sector, as with the flex-fuel technology.

If ethanol is used as an additive, defining targets to be achieved guarantees a minimum market size to suppliers and developers of biofuels, which would make an important contribution to the development of the industry (Harvey & Pilgrim, 2010). In this case, the Brazilian government estimates that by 2020 to achieve a mixture of 5% of all the world's gasoline, it would be necessary to at least double the current level of ethanol production (Interview with representative of the Ministry of Agriculture, 2010).

Nevertheless, the pace of growth of international production of ethanol has affected the interest of countries in adopting legislation to promote blending targets and the adoption of new technologies like flex vehicles through tax incentives. In Switzerland, for example, the lack of ethanol to meet demand has diminished the re-sale value of flex-fuel cars. Under these conditions, governments that take on a goal of a mix of fuels based on imports face a serious risk if they cannot guarantee an adequate global supply of biofuels.

To support the effort to build a stronger international market of biofuels, Brazil adopted technical cooperation with countries on the global south in biofuels production as a central component of its foreign affairs agenda. During the Lula administration, the Department of New and Renewable Energies was created as part of the Ministry of Foreign Affairs and the program Pró-Renova (Albertin & Messa, 2012). Brazil's policy states the first goal is to facilitate the efforts of those countries that have the potential to produce biofuels to become effectively self-sufficient in generating biofuels to reach a minimum goal of 5 or 10% mixture. To fulfill this goal, PETROBRAS has signaled that the strategy should include measures focused on both supply and demand, establishing the goal and bolstering production. The most likely scenario is that production will follow the creation of demand; although countries might initially require imports, as demand becomes secure, a domestic market with the potential to export should become consolidated.

Brazil is working through a two-fold strategy; direct South-South cooperation with countries located in the subtropical zone of the global south and triangulation of cooperation with the European Union and The United States. In most cases, the latter are donors, and Brazil is in charge of the technical cooperation based on its experience in sub-tropical agricultural production. The final aim of these efforts is to promote institutional development and human capital through technical cooperation (Albertin & Messa, 2012)

Brazil has signed more than 70 memoranda of cooperation and understanding with other countries regarding biofuels. As part of a trilateral cooperation agreement with the United States and Europe, it has also begun to assess conditions for the production of bioenergy (Kloss, 2012). In this context, Brazil has participated in the development of feasibility studies in countries in Central America, like Honduras, Guatemala, El Salvador, Haiti, The Dominican Republic, San Cristobal en Nevis; and in African countries, like Guinea Bissau and Senegal. These studies initially analyzed what would be the best crops for energy production, based on country conditions and on evaluations of climate conditions, such as soil, topography, etc. (Interview with representative of the Ministry of Foreign Affairs, 2010; Interview with expert of FGV, 2010).

The execution of these projects depends on funds from the Inter-American Development Bank, the Organization of American States and the European community, and technical contributions from Brazil, presenting the results to the governments of the relevant countries as a form of South-South cooperation. At the same time, the executive coordination of the project has sought to integrate the private sector through rounds of presentations of results, presentation of project portfolios and the development of financing mechanisms (Interview with representative of FGV, 2010). According to the executive of the Fundation Getulio Vargas (FGV) responsible for the project, the private sector's attention to this industry has been primarily centered on Brazil or on the United States, because of the potential domestic markets they represent. Therefore, they assume the Brazilian government will have to foster pre-inversion studies to increase the willingness of private investors to invest in other countries that might become producers of biofuels.

Within the Brazilian companies interested in internationalizing, the dynamic has come from those construction and infrastructure businesses that already have investments in those countries, and that see biofuels as an alternative to diversification, which could guarantee a biofuel supply for their projects. This investment can be seen in Angola, and there are also planned projects in Mozambique, Zambia, Liberia and Guinea, where the Brazilian mining business Vale also needs energy and finds itself financing feasibility studies (Interview with representative of FGV, 2010).

During the Lula administration, the African countries that received preferential treatment were those from the Economic Union of West African States (Benim, Burkina Faso, Costa do Marfim, Mali, Niger, Senegal, Togo e Guiné-Bissau, the Portuguese speakers African countries (Angola, Mozambique, Guiné-Bissau, Cabo Verde e São Tomé e Príncipe). A branch of EMBRAPA was created in Ghana (Albertin & Messa, 2012).

According to policy-makers from different institutions involved in these projects, countries that import oil have shown interest in diversifying their energy sources and resolving the innate problems associated with being a net importer of oil. At the same time, countries are worried about the potential impact of biofuels on food security. Given this concern, the rhetoric of Brazilian cooperation emphasizes the possibility of producing biofuels or agro-energy in a sustainable way along with energizing a country's agricultural development (Interview with representative of the Ministry of Agriculture, 2010). Senegal is one example where they were able to use sorghum oil to produce biodiesel and to isolate the protein that corresponds to 80% of the product as a foodstuff.

Similarly, some countries are said to be concerned not with the production of liquid biofuels, but rather the biomass for generating electricity. This is the case, for example, in Haiti, where electricity is produced by thermal generators that run on imported diesel and which still faced important challenges to electrification (Interview with representative of FGV, 2010).

The cooperation has included technicians' exchange; seminars about agricultural zoning and sustainable biofuels production held by officials from the Ministry of Agriculture, EMBRAPA, ABC, INMETRO, FGV, University of Saint Catarina and the Ministry of Foreign Affairs; policy instruments for biofuels production, innovation and technology in the industry; pre-investment studies; and the opening of an office of EMBRAPA in Ghana.

According to representatives of EMBRAPA (the Brazilian governmental institution responsible for the technical transfer), this type of project faces a number of difficulties, primarily the lack of technical capacity to complete a technology transfer in the receptor countries and gaps in the legal frameworks of countries that would be interested in producing ethanol or other biofuels (Interview with representative of EMBRAPA Agro energy, 2010). It is clear that the development of agro-energy projects in these countries is still inchoate, which makes the possibility of consolidating a supply among many countries in the short and medium term seem uncertain (Interview with representative of EMBRAPA Agro energy, 2010).

### 6.2.3 Standards and requirements at international markets

In the early 2000s, ethanol was considered an important mitigation measure in the transport sector, with the aim of substituting fossil fuels for a less pollutant alternative, and an industry that might promote green jobs and a green economy decoupling economic development and environmental degradation (UNCTAD, 2014). Over the time, however, NGOs and academics have questioned the sustainability of ethanol production and its contribution to mitigating climate change. Biofuels might disrupt food supply, impact biodiversity, and impact water quality and water availability. Additionally, doubts have been raised about the actual benefits of biofuels regarding the mitigation of GHG emissions, especially when indirect land-use change is taken into account (Calfucoy, 2012).

Regarding their socioeconomic impact, it has been argued that biofuel crops could compete with food production, threatening food supply security and adding pressure on agricultural land (Ford, 2007). The expansion of biofuel production also raises concerns about potential negative impacts on rural populations, both because of the effect on settlements and domestic migration, and because of the impact on land concentration due to the scale of production processes and the characteristics of the technology involved (Brazilian government, 2007). In terms of its environmental impact, biofuel's potential contribution to reducing GHG emissions has faced scrutiny because of the negative effects of the extensive land required for biofuel production and potential deforestation (Smeets et al., 2008).

Furthermore, there are concerns about biofuel's energy balance when considering the net impact of lifecycle production processes and the impact on indirect land use change[27]. When fertilization, transport, and emissions from deforestation, burning, peat-drainage, cultivation and soil-carbon losses are taken into account, the energy balance tends to be more negative than neutral[28] (Davis, 2007). Additionally, it is postulated that the carbon emissions from land-use change would have to be included in overall calculations of greenhouse gas emissions for specific biofuels. If biofuels are instead cultivated on existing

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[27] This effect is defined as the impact of producing biofuel feedstock on land directly converted from another type of agricultural land (EU, 2009)

[28] Among current technologies, only sugarcane- based ethanol in Brazil, ethanol produced as a by-product of cellulose production in Sweden and Switzerland, biodiesel from animal fats and used cooking oil can substantially reduce GHG emissions as compared with gasoline and mineral diesel. The other conventional biofuel technologies typically deliver GHG reductions of less than 40 percent compared with their fossil-fuel alternatives (Doornbosh, 2007)

agricultural land, it may then displace other crop production. Ultimately, this could lead to the conversion of rich biodiverse land into agricultural land. In response to social and environmental concerns, “in 2001 the EU introduced sustainability standards for biofuels imported to its domestic market, making biofuels subject to tighter sustainability regulation than any other source of energy or commodity” (Harvey & Pilgrim, 2010, p. 13).

Brazil’s response to ethanol’s sustainability requirements has been organized around at least two types of responses. For its part, Brazil, like other developing countries, has sought to make an international issue of the political implications of definitions of sustainability imposed on the world by developed countries. Brazil has also highlighted the negative impact these definitions have had on development opportunities for less developed countries, especially on their ability to plan agricultural development and land use, as well as to define areas to be preserved for conservation. All these decisions have local implications with respect to possibilities for economic development in the communities and in the country as a whole. As a representative from the Ministry of Foreign Affairs said in an interview, “Our position is to consider sustainability in three dimensions: social, economic and environmental, and in our vision the European position overemphasizes the environmental dimension and overlooks the need for considering economic and social development in those countries” (Interview with representative of the Ministry of Foreign Affairs, 2010).

Brazilian policy follows the principle that “Each country has sovereignty to plan the development of its agricultural sector” (Interview with representative of the Ministry of Foreign Affairs, 2010). Behind this sentence lies an argument about the fundamental autonomy of each country to define its own development path. The identification of land for the purposes of conservation or production is a determination with global consequences that directly impacts local opportunities for using the country's resources.

Brazil argues that the imposition of environmental sustainability standards to delineate the expansion of the biofuel production, proposed as a way to protect areas rich in biodiversity, is a mechanism to control the expansion of agricultural activities in the global south. Competition with these Northern countries, initially hampered by the imposition of high subsidies in food production in developed countries, is now undermined by GHG standards, despite the fact that more emissions are coming from countries in the North (Interview with representative of the Ministry of Foreign Affairs, 2010). As a representative from the Ministry of Agriculture (2010) said, "The Europeans deforested 99% and rebuilt 9%, now they have 10% [of land] recovered with forests. And now they want to dictate the rules for developing countries that haven't managed to expand their agricultural areas. Mozambique used to be an exporter of agricultural goods but it has become, largely as a result of Europe's policies of subsidies to the agricultural sector, an importer and its agricultural land has diminished over time… Initially, countries had to compete with subsidies from rich countries and now that prices are favorable again, they can't invest [in agriculture] because they will emit more than the Europeans want them to do."

Brazil has also argued that biofuels offer an alternative energy that can facilitate energy security in developing countries that are primarily oil importers, and can generate jobs and income for local economies, which should be considered in sustainability assessments. In particular, it claims that "countries that want to develop necessarily require energy to carry out the process and to do this, will they privilege fossil fuels that are 90% imported? It makes much more sense to develop a local industry that allows for energy generation in the country itself, circulating money in the domestic economy and also supporting the benefits of productivity in the agricultural sector" (Interview with representative of the Ministry of Agriculture, 2010).

To further this line of argument, Brazil is using international forums to lay out this view, arguing that because agriculture is a fundamental pillar of development in developing countries, to restrict agricultural expansion when prices are favorable and when there is a demand for biofuels where they are competitive would be to restrict their opportunities for wellbeing.

On another front, Brazil's response to the increase in sustainability requirements for biofuel production has been to emphasize the importance of creating local instruments and laws to regulate activity without letting these mechanisms be imposed on localities by foreign interests. From the standpoint of the Brazilian government, countries themselves should define how to manage and use their resources in a sustainable way. This view is reflected in the opinion of the Chief of the energy office from the Ministry of Foreign Affairs, who stated, "Each country has sovereignty to plan the development of its agricultural sector and should give precedence to the sovereignty of domestic legislation" (Interview with representative of the Ministry of Foreign Affairs, 2010)

In the case of Brazil, the government has worked to consolidate both the idea that production of agro-energy poses no threat to areas valued for their biodiversity and also for being a carbon sink for the world. This effort has inspired Brazil to adopt policies where competition in the industry and sustainability converge; thus, for example, they have deployed agro-ecological zoning in an effort to regulate the expansion of sugar cane production in Brazilian territory, giving special protection to zones with high levels of biodiversity and carbon stock (Da Silva, 2010).

Nevertheless, Brazil will need to increase sugarcane cultivation by something between 2.0 and 4.0 million hectares from the 5.6 million hectares under cultivation by 2007, in order to meet increased domestic and foreign demand for bioethanol and sugar. Even though this represents an increase of between 50 to 80%, the Brazilian Government, together with the sugarcane industry, holds the view there is sufficient unused agricultural land for the proposed increase in production, although it will mean exploiting additional 3% to 4% of the available agricultural land. “The bulk of the growth in sugarcane in the next few years is expected to be concentrated in the western Sao Paulo region, the borders with Mato Grosso and in some areas within the state of Goias” (Duffey et al., 2007)

However, the institutional capacity to control the expansion of sugarcane monoculture in degraded pasture areas and "campos sujos" is questionable. Even though new government regulations demand serious environmental impact studies and take more than two years to grant environmental licenses to new distilleries, Brazil has not yet consolidated the integrated use of spatial data and information (geo-referenced data) to show sugarcane growing expansion areas by the institutions/researchers associated with the sugarcane sector (Duffey et al., 2007).

## 7 PRINCIPAL LESSONS LEARNED AND FUTURE PROSPECTS

Brazil maintains its position as a big player in the biofuels market, acting as the main producer and consumer of ethanol for its domestic market. Since 2000, as the ethanol industry moved to a new stage of development, Brazil has initiated a process of internationalization through the leadership of the government and in close cooperation with the private sector to strengthen Brazil's position as an agro energy power, mainly as a global producer of ethanol and a leader in the industry's global value chain. In this pathway, Brazilian faced important challenges and difficulties in prospering with the idea of making ethanol an international commodity making explicit the challenges for state from developing countries to manage the internationalization of their commodities and the possibility of building international markets for their products.

Based on personal interviews with stakeholders from the public and private sector and analysis of secondary information, this paper identifies, from the perspective of the main stakeholders, the complexities in building a global market, emphasizing the difficulties of governing a domestic market to guarantee the supply of a strategic good such as biofuel, and underscoring the relevance of the articulation between foreign affairs and industrial policies as Brazil seeks to increase its participation in the global biofuels market while also responding to domestic demands that the industry respond to new sustainability standards.

The prospect of making ethanol an international commodity was affected by the supply crisis after 2008, underlining the complexities involved in the effort to balance the market supply of a key commodity like energy. Because technological conditions can make difficult for consumers to seek for alternatives in the short run, the supply must be guaranteed by regulatory agencies of the state. In 2010, when the industry began a period of contraction that affected the ethanol supply at the local level and kept exports just at the point required to fulfill already-signed contracts, the Brazilian ethanol market showed its weakness, calling into question the industry's ability to guarantee supply, and lowering expectations of increased national production to consolidate an international-level market. The vision that ethanol could expand to foreign markets, predicted in the first half of the decade, changed over time.

At the same time, the contradictions and conflicts of interests that exist at a global level in the development of alternatives to fossil fuels within the energy sector can also be seen within Brazil, and have doubtlessly influenced the biofuel industry's capacity to reach a position of greater leadership within the market. Despite the support expressed by the Brazilian government for the development of a biofuel market, different logics and interest within the Brazilian government complicate its efforts to expand the ethanol market.

Additionally, the ethanol market faced difficulties in building an international governance system. Even though the Brazilian state worked to consolidate international standards and to address technical barriers to trade with other countries, the ethanol industry is confined within two highly sophisticated and politically relevant markets, the energy sector and agricultural goods, affecting the market's evolution. As a biofuel, ethanol is still defined as an agricultural good by the WTO and is affected by protectionist measures from the developed world, while at the same time, it is also part of the energy market, highly controlled and sensitive to transnational interests, where there is no international forum to discuss energy issues that might defend the interest of non fossil fuel producer countries.

At the beginning of 2000, ethanol was seen as a key alternative to mitigate GHG and the possibility of building a sustainable industry that might tend toward a green economy decoupling economic development and environmental degradation (UNCTAD, 2014). Over the time, many questions about its sustainability have risen, including potential disruptions of the food supply, its impact on biodiversity, on water quality and water availability, and doubts about the actual benefits of biofuels in terms of the mitigation of GHG emissions, especially when indirect land-use change ("ILUC") is taken into account.

In terms of strengthening the global market, Brazil has worked to build global suppliers through South-South cooperation mechanisms with African and Central American countries. To date, however, there have been no major changes in the number of producers of ethanol globally, even considering production oriented to fulfill purely domestic demand.

Finally, Brazil's response to ethanol's sustainability requirements has a political and a technical dimension. Like other developing countries, Brazil has sought to make an international issue of the political implications of the definitions of sustainability that have been imposed on the world by developed countries, and of the negative impact these definitions have had on development opportunities for less developed countries, especially in their ability to plan agricultural development and land use, or to define areas to be preserved for conservation. At the same time, Brazil's response to the increase in sustainability requirements for biofuel production has been to create local instruments and laws to regulate activity without letting these mechanisms be imposed on localities by foreign interests. From the standpoint of the Brazilian government, countries themselves should define how to manage and use their resources sustainably.

Even though there are conflicts in the implementation of policies to support the domestic and international market of ethanol within Brazil, during Lula's government, a high level of coordination among ministries and the private sector prevailing, allowing the industry's productivity and sustainability to increase (Interview with representative of the Ministry of Agriculture, 2011). This level of coordination changed over time, however, and by 2011, when the interviews for this study were conducted, most interviewees described weakened relationships and a halt to the Presidency's previous efforts to hold formal and informal meetings to coordinate ethanol promotion policies. The state's capacity to coordinate private-public actions and to guarantee a coherent and clear strategy has diminished over time, along with the prospects of increasing the participation of Brazil at an international biofuels market.

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# CHAPTER 3

# BUILDING INSTITUTIONAL CAPACITIES FOR CLIMATE CHANGE POLICIES: THE CASE OF MAPS CHILE

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# 1 INTRODUCTION

Climate Change has gradually become an important issue on the political agenda in developing countries. The urgency of this was initially only fully understood by the scientific community and those directly involved in the international negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). Today, however, it is a prominent topic with growing public awareness (Schmidt et al., 2013) and it is an integral part of the discourse of major world leaders when speaking about the main challenges to be faced in the future (Father Francis, 2015; Obama, 2015). However, there is still a gap between this discourse and concrete action.

The political economy behind a phenomenon mainly driven by the prevalence of a fossil fuel economy, has contributed to the fact that most countries are still reluctant to make the commitment required to achieve the ambitious goal of limiting global warming to less than 2°, as recommended by the IPCC (Climate Action Tracker, 2015). Addressing climate change implies complex socioeconomic transformations that call for significant socio-economic changes. In order for this transition to be successful, there needs to be high levels of interaction between the various stakeholders within and across countries.

Across developing countries, climate change still competes with other urgent development priorities such as: education, health, housing; and more salient and difficult processes across developing countries such as: wars, peace processes, reconstruction processes (due to natural disasters) and the resolution of local environmental issues. Additionally, at institutional level, the State does not seem to be prepared to address the challenges posed by Climate Change (Echeverri, 2000). While many countries have strengthened environmental institutions and have created specific departments to address this issue, the results are still insufficient. Most countries lack financial resources and technical capabilities. They have no defined legitimate and shared objectives, and above all, lack the required leadership to facilitate the coordination and transformation that Climate Change policies demand (Kane, 2014; and Dingwerth Biermann, 2004).

While climate change poses significant challenges for public policy everywhere, for developing countries, under the current climate regime, the scenario seems particularly difficult. There is need for new skills and institutional capacities at both technical and political levels to formulate and implement mitigation actions and compromise Intended Nationally Determined Contributions (INDC) that will certainly impact the development path of the different countries.

Countries are challenged to define public policies regarding climate change under conditions of risks and uncertainty. Making projections for the future and having to make decisions for the present using information that is always incomplete poses challenges in terms of creating prudent political agendas that are long-term and consistent with the various interests and political priorities (Giddens, 2009). At the same time, in order for them to be effective, decisions regarding action against climate change must be taken preventively: they should be taken now to impact in the future. The decision-making processes and the cost and benefits of moving forward should transcend the particular interests of any particular government.

As part of its climate change policy, in 2010 Chile took on the task of gathering national data for making long-term projections of scenarios and options of greenhouse gas (GHG) mitigation to support its position at the international negotiations on climate change and to evaluate alternatives contributing to low-carbon development in the country. It was carried out through the MAPS-Chile project, an experience that emerged from a South-South cooperation initiative and which consist of a process of co-production of knowledge through scientific research and multi-stakeholder involvement for estimating the emissions baseline and evaluating measures and mitigation scenarios. The process included the participation of numerous stakeholders from the private, academic and public sectors, which were coordinated by a public-private partnership and directed by government bodies.

The MAPS project led to many contributions: building estimations of GHG emissions for the country taking the entire economy into account, generating information regarding mitigation actions, and estimating the macroeconomic impact of implementing different mitigation scenarios. The analysis of MAPS is particularly interesting in providing an opportunity to observe a model to produce scientific evidence about complex issues with the final aim of building institutional capacities across developing countries to improve decision-making and policy design around complex issues characterized by high levels of uncertainty and requiring systematic action from different stakeholders and institutions on sectorial, local and national levels as well as seeking responses and actions for the medium and long terms. Therefore, it is of central interest to describe and analyze the methodological approach used in the project, specifically the design and management, the system of governance applied, and the interface between scientific research, multi-stakeholder participation and the public sector.

The research method applied in this study was qualitative, to understand the reality and social phenomenon from the perspectives, views, perceptions, experiences and practices of the actual stakeholders. The analysis was based on a review of secondary data – mainly official project documents, digital sources such as videos and webpages, meeting minutes and reports on results, as well as on individual semi-structured interviews. The central analysis comes from the interpretations and evaluations made by the stakeholders of the processes they participated in, together with a post-analysis by the researcher to conceptualise and construct a narrative from the content using a grounded theory approach.

This paper proceeds to, first, present a review of literature relevant to the topic in order to contextualize the project and develop a framework for the analysis from the perspective of sociology of science and technology. Then the main aspects of the MAPS project are described: its origin, organisation, system of governance and how it deals with two strategic issues – the effect of uncertainty and the challenges linked to a long-term approach for the definition of climate change policy. Thirdly, the MAPS participation process is described and analyzed, with the aim of understanding its contribution to co-producing knowledge for policy making. Fourthly, the most important project impacts to date, both on public policy and individual levels, are looked at; and, finally, the main lessons and future challenges are outlined.

## 2 BUILDING EVIDENCE AS AN OPPORTUNITY FOR INSTITUTIONAL CAPACITY BUILDING

International cooperation on Climate Change has emphasized the role of quantitative evidence as a critical and desirable starting point for defining policies to mitigate Climate Change based on GHG estimates, abatement costs quantification, and economic impact evaluations. At the same time, the international community has been called to produce quantitative information to support pledges to mitigation from different countries, with the aim of guaranteeing that commitments can be tracked and verified and that a ton of CO2 measured in X country is recognized as a ton by all the international community. Most of the countries that are formally initiating their design and formulation of Climate Change policies follow the same process: i) building data to measure and monitor Climate Change; ii) evaluating potential mitigation actions (relying on international methodologies); and in most cases, experiencing processes that are mostly externally driven and tailored to the requirements of the international community of practice on Climate Change. Building quantitative evidence not only seems to be relevant, but also a legitimate pathway to define public policies on Climate Change across countries.

However, there is a long tradition from the public policy studies of discussing the role and contribution of evidence in policy-making, positing the question about how do we transform the processes of evidence building into an opportunity for domestic capacity building to transit toward a low carbon development. From a sociological perspective, science and the process of building evidence are socially constructed processes. Therefore, it is necessary to be aware that there are multiple alternatives to address these tasks, and that different approaches can facilitate or hinder the contribution of an evidence-building process for the domestic requirements of developing countries. Thus reinforcing the generation of knowledge contextually situated and potentially useful to trigger processes of social learning that can contribute to necessary transformations to transition toward a low-carbon development.

On the one hand, promoters of an evidence-based policy-making approach argue that policy and practice that is not informed by the best available evidence runs the risk of poor effectiveness, implying the potential paradox of implementing public policies that might actually harm society, more than benefitting it (Davis, 2005). In turn, Judge & Bauld (2001) argue there is a strong ethical case for ensuring that scarce resources are directed into those policies that the evidence suggests are likely to be most effective in addressing social problems. Specifically, on the issue of environmental policy, it is argued that science and public policy cannot be considered disconnected from each other, but as systems that constantly exchange views and products, which are mutually defined, while they generate a common practice that strengthens environmental governance (Shackley, and Wynne S., B. 1995).

On the other hand, from an approach more linked to empirical analysis, it is argued that even though scientific evidence can be important for informing policy-making from a normative approach, it is not necessarily used because policy-makers take decisions based on multiple criteria beyond scientific results (Sanderson, 2006). In this sense, research results can be one of the many inputs for the policy process, and not necessarily the most influential. The contribution of evidence is usually surpassed by powerful political forces of inertia, expediency, ideology and financial concerns (Walker, 2000). It is also argued that policy-makers dismiss scientific evidence because of timing issues (they need to make decisions with urgency, without considering the time necessary for doing research). They also do so because of a lack of technical capacity and a tendency to disregard information that seems too complex, or evaluations and implications that are difficult to understand (Cable, 2003). In addition, the role of personal values, experience, ideology and political insights has been gauged to explain why policy-makers usually give low priority to the use of evidence or simply decide to dismiss evidence to support policy decisions (Davies, 2005).

From a different perspective, the sociology of science and technology literature argues that whilst the relationship between science and policy-making remains relevant in our societies, it is necessary to understand how this relationship has changed over time and which new approaches are necessary to facilitate a fruitful interaction. From a rational analysis of decision-making processes, there is inter-dependence between values that proceed from interest situations, and techniques and knowledge that emanate from the scientific realm that can be utilized for the satisfaction of value-oriented needs. In this model, there is no strict separation between the functions of the expert and the politician; rather there is a critical inter-relationship, which creates an unavoidable intersection between science and policy (Van den Hove, 2007).

In addition, in our contemporary societies, it is argued we are experiencing an epistemological shift that puts the concepts of "risk" and "uncertainty" at the center of social life, and therefore also at the center of scientific development and policy-making. Surprisingly, considering what was expected from a modernist point of view, a higher level of knowledge and sophistication of the technological system has deepened the perception of risk and ignorance (Beck, 1992), showing that scientific and technological development has not brought greater certainty. On the contrary, it has engendered more and more uncertainty and a sense that our ignorance is greater than our knowledge (Callon, 2009: 19). Thus, whilst science offers formal assessments based on logical reasoning, it cannot delivery absolute truths, nor absolute solutions (Jasanoff, 2003).

Meanwhile, the political system, even though it can justify its decisions using scientific evidence, faces high levels of scrutiny by the public. This is not only because of distrust in the decisions by the political system, but also because the public has become aware of the prevalence of radical uncertainties around issues of the environment, bio-technology, health implications and Climate Change, as well as many other topics. Scientific evidence cannot constitute a clear source of information and solutions, creating socio-technical conflicts that demand new approaches to produce and validate knowledge and decision-making (Callon, 2009).

As one of the possible answers, Jasanoff introduces the concept of "technologies of humility" understood as "methods or habits of thought" that seek to deal with the unknown, uncertain, ambiguous, and uncontrollable, recognizing the limits of prediction and control. These technologies recognize our inability to predict the future and all the implications of our actions perfectly, and therefore promote the development of governance structures to articulate different capacities of experts, decision-makers and society in general (Jasanoff, 2003).

In the same vein, the concept of "post-normal science" states that when public policy decision making became complex due to uncertainty, as in the case of Climate Change policy, scientific knowledge remains valuable, but it can only deliver partial understanding of a particular phenomenon (Van den Hove, S., 2007; Sarkki. et al., 2014; Engels, A., 2005). In this situation, the scientific community is called to share and validate their findings with a wide range of society actors (Sedlacko, M. et al., 2013). This means that researchers might need to open the 'black box' of research practices, thematising assumptions and the methodologies they use (Callon, 2009; Van den Hove, 2007). This can result in the formation of peer review communities that allow anyone (experts and non experts) interested in contributing and ensuring the quality of the process to participate through the review of methodologies and scientific findings and a process of co-production of knowledge. This means building a dialogue process that allows a plurality of perspectives to gain acceptance; and at the same time strengthen and provide relevance to scientific evidence (Funtowicz, S. and Strand, R., 2007).

Through these processes of co-production of knowledge, "facts are accepted as authoritative, not necessarily because they can be empirically verified, but because they are validated through processes of informal negotiation and can be ranged into frameworks of shared assumptions and inferences" (Jasanoff, 1987). In this sense, processes to build trust become relevant to increase credibility. "Without such trust relationships, then no matter how well the science is produced on its own terms (rigor, accuracy, robustness), it will struggle to be accepted" (Wynne, 1991; Wynne, 1992; Wynne, 2007). From the sociology of science and technology perspective, a basic understanding is that scientific evidence is always socially produced, and current conditions of complexity and uncertainty of the modern world demand new practices for facilitating the interaction between scientific work and policy-making processes.

# 3 THE MAPS PROJECT IN CHILE

Mitigation Actions Plan and Scenarios (MAPS) is a programme based on a South-South collaboration facilitated by a South African team, with the aim of building evidence to inform Climate Change policies in developing countries. Based on the experience of the implementation of the Long-Term Mitigation Scenarios (LTMS) project in South Africa in 2005-2008, the MAPS Programme created a methodological and organizational approach that was contextualized and implemented by four countries in Latin America (Brazil, Chile, Colombia and Peru). The MAPS Programme was originally defined by a focus on enhancing collaboration between developing countries with the aim of generating robust, legitimate and credible knowledge regarding mitigation scenarios and future pathways for low-carbon development.

Its methodological approach included building evidence using domestic research by participating countries, together with a participatory process involving stakeholders from all national sectors, to co-produce knowledge about mitigation scenarios. The organizational approach included the development of a governance structure to articulate the participatory process and the interface between research activities, public policy and stakeholders' interests. This approach anticipated increasing the legitimacy, robustness and credibility of evidence by enriching the traditional way of addressing scientific research – made by researchers on their own – through a facilitated process with local experts from multiple sectors and disciplines. Research products across the processes have included reference and mitigation scenarios, action plans, mitigation action libraries and the evaluation of socio-economic implications of mitigation actions, among others.

The main hypothesis behind this approach is that "co-production of knowledge fundamentally transforms how the research is conducted and knowledge is produced" (Raubenheimer, et al., 2015). The final aim of the project is to achieve lasting transformational impact, country ownership, long-term understanding with deep stakeholder engagement and world-class modeling (Kate Hampton, CIFF cited at Raubenheimer, et al., 2015).

To date MAPS includes the following processes:

- Implicacoes Economicas e Sociales (IES) Brazil, 2013-15 in Brazil,
- MAPS Chile, 2011-2015 in Chile,
- Planificacion Ante el Cambio Climatico (PlanCC), 2012-2015 in Peru,
- and the Estrategia Colombiana de Desarrollo Bajo en Carbono (ECDBC), 2010-2015 in Colombia (Maps, DNA, 2015).

Each country has had the autonomy to adjust the approach and methodology according to its own institutional, political and economic contexts. As part of the South-South collaboration, the programme creates a knowledge platform for researchers and facilitators from all MAPS countries to share lessons and construct good practices for research; and for the design and implementation of the co-production process.

At COP15 in Copenhagen in December 2009, Chile announced its willingness to contribute to global mitigation efforts by achieving a reduction of 20% from its emission baseline by 2020. The definition of this goal was a political commitment, in which there were no formal estimates of the emission baseline for the country and of how much the deviation of 20% equalled in tonnes of $CO_2$ was.

During the first quarter of 2010, the government's National Environmental Ministry headed an inter-ministerial taskforce, through the Inter-ministerial Technical Committee for Climate Change, in order to come to an agreement on the information Chile would present to the United Nations to be included in Appendix II, where developing countries register Nationally Appropriate Mitigation Actions (NAMAs) to be implemented by 2020. The President of the Republic declared in a speech on the 21 May, that 'On matters concerning greenhouse gases, global warming and biodiversity, Chile commits to achieving a reduction of 20% by 2020' (Piñera, 2010), thereby entrenching further the political commitment to the goal proposed by Chile. In mid-2010, the Ministerial Committee for Climate Change approved the declaration and officially communicated Chile's voluntary commitment to the

UNCCCF Secretariat through a national focal point, carried out by the Ministry of Foreign Affairs on 23 August 2010. Chile's voluntary commitment formalized in 2010 set out the following: 'Chile will implement Nationally Appropriate Mitigation Actions (NAMAS) in order to achieve a 20% deviation from the business-as-usual emission increase trajectory by 2020, based on projections from 2007.' The declaration also stipulated the need for a relevant degree of international support to achieve this goal. It stated that 'the main focus of the NAMAS would be on measures relating to energy efficiency, renewable energies, land-use, land-use change and forestry'.

Parallel to this, in mid-2010 the director of South South North, Stefan Raubenheimer, who designed and implemented LTMS in South Africa, together with Harold Winkler, the director of the Energy Research Centre at the University of Cape Town, presented the MAPS programme in Chile inviting the country to participate. As a project that was part of South-South cooperation, the first point of contact was through the Chilean Chancellery. According to interviews conducted with officials and ex-officials from the Climate Change Office of the Ministry of Environment, the initiative seemed innovative and of interest in that it provided the possibility to discuss evidence (based on constructing scenarios) for decision-making and for strengthening Chile's position in the international arena, that might facilitate the articulation with the other ministries and institutions across the Chilean government. The MAPS initiative was presented to the Ministerial Climate Change Committee on 13 August 2010, where an expression of interest was granted to the initiative, in order to begin developing a low-carbon development strategy for Chile. The collaboration was formalized through a letter to South Africa, dated 17 August, from the Directorate of Environment of the Ministry of Foreign Affairs stating Chile's interest in participating in the MAPS programme.

The MAPS Chile design was overseen by a local consultant, Eduardo Sanhueza, who was central to setting up the programme in Chile. The initial structure of governance was based on the international model, comprising a steering committee, an executive secretariat, a scenario building team and technical working groups. During the first stage of development, the Ministry of Environment assumed the role of Executive Secretariat and officiated the national ministries for nominations for the steering committee. The first Inter-Ministerial Steering Committee meeting was held in January 2011, attended by representatives from the Ministries of Foreign Affairs, Finance, Transport, Energy, Agriculture and Environment. At the meeting, Stefan Raubenheimer presented the programme and the key issues to be addressed by the Steering Committee. It was also agreed that Eduardo Sanhueza would continue providing technical support for the development of descriptive reports and defining the roles of the various working groups, the definition of the key questions Chile should address during the process and the most challenging task of obtaining a high-level mandate to provide political support for the initiative.

The Steering Committee met monthly and had, by April 2011, selected the two leaders of the project, a head of research and a head of processes, as well as an agency for implementing funding and a preliminary list of members of the scenario building team. By mid-2011 the project design was developed in detail in the 'Project Document, PRODOC' which enabled communication on the project and procurement of international funding. Once the Project Executive Committee was formed, including the leaders of research and processes, a research team and an executive secretariat, the Steering Committee took a more decisive role and the project progressed at a quicker pace.

The personal skills of individuals in the Climate Change Office of the Ministry of Environment allowed them to leverage international funding. New members were committed to achieve funding to support the activities of the Climate Change Office even as a new office with minimum resources (interview with OCC Official). They used their language skills, their political and personal networks and their ability to work with international organizations. In addition, these people had the ability to network politically with the main authorities in different institutions, particularly in the Ministry of Finance that can veto any important issue for the government, and in the Ministry of Foreign Affairs, the institution responsible for formalizing the Chilean position on climate change in the international arena. With them, the Office of Climate Change built a relationship of collaboration and political support (interview with OCC official).

In January 2012, seven ministers under the leadership of the Minister of Environment, Maria Ignacia Benítez, signed a high-level political mandate in Cerro Castillo, a Presidential Palace in Viña del Mar and the location of important national political events. Funding for the project was successfully gathered from international donors, and the members of the scenario building team were invited to meet with the Minister of Environment. In March 2012, the MAPS Chile project was formally launched at a public event attended by various high-level authorities. The first scenario building team meeting took place in March 2012, inaugurating a work project of two years – later extended to four years.

The initial stages of MAPS Chile occurred in a favourable political context for climate change issues. The country had recently made its political commitment to reduce emissions by 20% by 2020, which required a technical base to advance the formalization of Chile's agreements in international negotiations. In that context, the project was presented as a non-binding process that would rely on the best scientific research available in the country to build the numbers to support the Chilean definitions. In addition, other experiences with climate change issues in the country, such as the round table discussions between civil society organizations and the private sector to evaluate the 2008–2012 Climate Change Action Plan made it clear to the Climate Change Office that there was a strong demand for the creation of participatory spaces and to involve more people interested in these discussions, as well as to generate information that could provide an integrated view in terms of methods and coherence of results. Moreover, the Climate Change Plan established a series of goals and GHG projections on a sectorial level, made independently by each sector using its own methods and assumptions, making it difficult to establish a global view of future emissions in the country.

Faced with this challenge, MAPS International presented a valuable opportunity as it offered an approach and work methodology that resonated with the national authorities for the following reasons:

(i) The possibility to define an emission baseline for the whole economy of the country;

(ii) Its focus on gathering technical information, a strategic way to address the agreements with the different institutions and stakeholders;

(iii) Its approach to building mitigation scenarios, leaving political decisions to the government; and

(iv) The possibility it provides to identify the impacts of mitigation strategies on the country's economy. The component of participation, which is central to MAPS' proposal, was understood and valued throughout the project process.

The technical and political skills of the individuals who headed up this stage of the project were critical as they were able to engage authorities, generate political support for developing the initiative, and engage on the international arena in order to obtain the resources for the project.

### 3.1 Project Structure: Designing A System Of Institutional Governance

From the outset, the MAPS project has been characterized by its organizational structure, which assigns different roles and functions to different institutional bodies. Together, these constitute a system of institutional governance in which public and private stakeholders coordinate around the task of producing information for decision-making on public and private levels. The figure below shows the main organizational bodies that make up the project and their functions.


Figure 1: Project Structure

The organizational bodies defined in the project were:

The **Strategic Advisory Committee (SAC)** was specified as the highest political body, with a direct communication link with the ministers. The SAC met on five occasions between 2011 and the beginning of 2013. Its purpose was less complementary than had been anticipated with the Steering Committee, which eventually took responsibility for guiding the strategic definitions of the project from the political stage.

The **Steering Committee (Steering Committee)** is responsible for making the main decisions on the project. It meets monthly and is made up of representatives from the seven participating ministries: Foreign Affairs, Finance, Transport and Telecommunications, Agriculture, Energy, Mining and Environment. The executive team coordinates the meetings. Participants at the meetings were the leaders of research and participation, representatives of the Ministry of Environment and the project administrative body. The Steering Committee revises proposals and preliminary and final results and it can partner up and assist with studies developed for the project that are in its line of competence and interest.

The **Executive Committee (EC)** was integrated by the secretariat, administrators of the project (UNPD), sectorial researchers from the University of Chile, the macroeconomic analysis team from the Catholic University and the participation processes team.

The **project secretariat** is defined as the coordinating body and is responsible for national and international communications on the project and for supervising the Executive Committee, reviewing administrative and technical research and participatory matters. In practice, the head of processes together with representatives from the Ministry of Environment took on the main coordinating role and passed on the administrative functions to the technical secretariat.

The **head of research**, Rodrigo Palma, oversaw design and supervision of all research activities. He monitored the quality and integrity of results.

The **head of processes** and facilitation, Hernán Blanco, oversaw the design; implementation, monitoring and reporting on all activities related to the participatory, research and dissemination processes.

The UNDP was in charge of implementing the project in phases one and two and managing administration of funds.

The **Scenario Building Team (SBT)** is the multi-stakeholder group that participates in developing the project. It is made up of nearly 70 individuals with proven experience in climate change and related topics (mitigation, adaptation and sustainability issues). The participants are from the public, private and academic sectors, and organizations and institutions from civil society. Participation is on individual, not institutional, terms. The group works according to guidelines provided by the Steering Committee and the head of processes facilitates the sessions. It is an advisory group and its recommendations are not binding.

Setting up the Scenario Building Team was a particularly sensitive task. It was formed after a discussion on criteria for participation proposed by Hernán Blanco (leader of participation), Rodrigo Palma (leader of research) and Andrea Rudnick (Head of the Office of Climate Change) to the Steering Committee. The criteria for participation were: to have people with knowledge and experience regarding climate change and related topics, with knowledge of and access to information in the relevant sectors (such as energy, forestry, agriculture and technologies), with strategic thinking skills, the ability to take action beyond the parameters of a specific sector, an understanding of and agreement with the project rules; in short, people with a known track record who are recognized for their technical leadership.

Individuals from academia, the public sector and NGOs formed part of the team. One of the notable shortcomings identified was low participation by NGOs. A fund was created to cover the costs of their participation but it was not as successful as expected. Some of the reasons cited by individuals who did not attend regularly were: a need to focus on specific and contingent topics in view of the urgency and relevance of the short-term agendas for environmental issues in the country, a lack of interest resulting from the way that the problem was approached because of an over emphasis on sectorial issues without addressing local and territorial challenges, and a preference for implementation and political issues opposed to the focus on research adopted by MAPS, among others.

Specific and ad-hoc working groups supported the technical work per sector. The technical working groups were composed of Scenario Building Team members and individuals invited in their capacities as experts. Their main contribution was to gather information about the micro-dynamics in sectors in order to refine modelling and evaluations of mitigation measures, specifically where there was a dearth of information or records making it impossible for researchers to work independently to establish appropriate assumptions and methodological definitions.

**Consultants** were in charge of developing specific studies outlined in the project research framework. The use of consultants is the main difference between the Chilean and South African experience. In South Africa, consultants were not employed: in contrast, a permanent team of 30 people was responsible for conducting all studies necessary for the project.

## 4 Main Characteristics of the MAPS Chile project

According to stakeholders who participated in the project, there are three characteristics that were highlighted by everyone as the most remarkable feature of the MAPS-Chile project: i) its governance, and in particular the governmental connection – with the potential of influencing the public agenda despite not being binding; ii) the quality of the research conducted; and iii) the participatory process, the innovativeness of incorporating a method for a broad participatory process for generating information to define a public policy. Below are some observations made on each of these characteristics

### 4.1 Governance

The government – through representatives from the Ministry of Environment and, particularly, the Climate Change Office – was seen as the leading body of the project, maintaining a continual governmental presence throughout the project development. The project mandate, which was incorporated from the beginning of the project, was signed by six ministers and explains the goals and scope of the project. This is recognized as an important element in terms of providing political relevance to MAPS Chile and of explicitly expressing government support. For the project participants, the creation of a steering committee that included representatives from seven ministries represented the political relevance of MAPS and is recognized as a positive indicator in terms of the project's potential capacity to have an influence on decision-making.

The structure and organization of the MAPS project created a system of governance that, according to participants, offered an alternative approach to responding to relevant challenges when defining climate change policy. It also offers an approach on how to deal with uncertainty and information gaps when estimating and projecting mitigation measures for the long term, as well as creating cross-sectional long-term agreements to advance in finding solutions.

### 4.1.1 Constructing Long-Term Outlooks: The Autonomy Of Political Administration Versus Political Articulation.

As part of the challenges of defining a long-term outlook, the need for two principles was considered when putting the project team together (including all the stakeholders involved). It was necessary to ensure that the project work remained sufficiently independent and that the results would not be directly linked to a specific government's agenda, while also ensuring that work would stay within the radar of politicians and the government, and would be relevant to the political agenda of the country. In order to maintain this precarious balance, a major role was played by the project governance, and therefore by the Steering Committee, the Scenario Building Team and the Executive Committee. The Steering Committee made sure that the project remained politically pertinent and relevant throughout the project. Continuous report-back on the progress of the project results kept the authorities, at least the middle ranks, continually linked, and at the same time it facilitated a connection between the EC and the needs and interests of the multi-sectorial representatives of government. In addition, the Steering Committee played a role in resolving conflicts as it took on the role of political authority for resolving differences between the Scenario Building Team and the Executive Committee.

The Executive Committee – made up of a research team that included two prestigious local universities (the University of Chile and the Catholic University) provided institutional backing to the technical definitions, adding to the credibility and legitimacy of the results (Interview with member of the scenario building team).

Based on this, interviewees considered the organization around dealing with the change of government in March 2014 as a project success. The change posed a significant threat to continuity of the political support for the project, especially since the opposition to the current government (which was managing the project) became the new administration. The head of processes, Hernán Blanco, played an important role in coordinating and overseeing the internal project process, as well as the project's relation to its social and political environment. In anticipation of the change of government, Blanco held numerous personal meetings with members of the Scenario Building Team, with potential new authorities and with people linked to the incoming government, in order to introduce the project and create awareness of its relevance.

Although these efforts were considered relevant by the interviewees, one of the conditions evaluated as critical for facilitating the transition was the significance to the project of the Scenario Building Team, where members and consultants became new government authorities and people linked to the government who left their posts, sustained their technical involvement in the topics, thereby providing the best conditions for the project's continuity.

At the same time, the proximity of COP 20 in Lima and the need to provide contextual information during the negotiations generated political support for the continuity of the project. In view of this the next phase of the project, after COP 20 and upon finalizing the Phase 2 results, will probably represent the real political shift that needs to be dealt with and overcome.

The Scenario Building Team was provided with the opportunity to write a chapter of the final report – which is an example of its autonomy and independent expression. The aim of the chapter was to develop a narrative around the statistics generated in the study, and an interpretation of the results according to the participants' expertise. This ensured that a group of at least 12 people from different sectors conducted an in-depth study of the results and formalized their impressions on the scope of the results. The exercise had the primary goal of creating an independent narrative by the Scenario Building Team (developed by voluntary participants) and also to enable the possibility of creating a closer link between the project results and the public policy agenda.

Even though the participation of the representatives at the steering committees was not completely stable, their formal constitution facilitated the articulation of the project with the government. The multi-sectoral participation diminished the level of contestation of the results. This validated the argument that a continuous relationship among players contributes to establishing trust, and increasing the credibility of the results beyond their rigor, accuracy and robustness (Wynne, 1991; Wynne, 1992; Wynne, 2007).

In addition, the formation of Steering Committees facilitated the transition from the delivery of results by MAPS to the definition of the INDC because most of the team members were involved in both. In the case of Chile, the Committee for the INDC corresponded almost exactly to the Steering Committee of MAPS-Chile, facilitating the translation of results, and the understanding of its implications and uncertainties.

Finally, the third key component of the governance structure was the formation of an advisory group and technical working groups. This strategy was to facilitate the process of co-production of knowledge and to provide legitimacy to the results. Technical meetings with experts facilitated in all three countries filled the gaps in information and validated the methodologies, parameters and assumptions for the modelling process. In turn, the Scenario Building Team, as an advisory group, contributed with the same tasks but also provided support and legitimacy to the process. Not all countries addressed the relevance of strengthening personal relations among the stakeholders involved in the process in the same way. It remains a key issue to understand these processes as socio-technical processes. That means including into the evidence-building process, human relationships as a critical factor; with the aim of building a trusting and fruitful cooperation based on setting clear and legitimate rules, working with impartiality, acting with respect and truly recognizing the contribution of all the people involved in the process.

## 4.2 Quality of Research

The research conducted as part of the project is considered to be of a high quality for being rigorous and innovative, but the value of generating information based on empirical data was emphasized (interview with Scenario Building Team). It was a common view that the results of MAPS Chile provide the best available information for estimating emissions in the country and for evaluating potential mitigation measures and scenarios (interview with Scenario Building Team and consultants).

Contracting the Centre for Energy at the University of Chile provided a stable team for the project, which enabled the topics to be developed and the lessons learnt to be integrated throughout the project duration. This view signals a counterpoint in terms of the difficulties of working with consulting teams, which generally experience frequent rotation, particularly for projects of more than two years.

The research was organized by sectors and tendered to institutions and specialists. In addition, economic issues connected to sectorial evaluations and general equilibrium analysis of the mitigation measures were handled by economist Rodrigo Fuentes and his team from the Catholic University. Initially José Miguel Sánchez from the Catholic University acted as head of the team and contributed to the methodological design of the project. The MAPS research team included people from the two main universities in the country, strengthening the credibility of the project results.

As previously mentioned, the research team was made up of professionals from the Centre for Energy at the University of Chile and the Faculty of Economics at the Catholic University. Initially the universities could not provide climate change experts. This, according to the head of the Climate Change Office, Andrea Rudnick, was an advantage at the beginning of the project as it reduced the bias between mitigation measures and the possible methodologies to be used. However, at critical points, when embarking on certain studies or integrating results, it was a handicap in that contributions from an expert view on materials for negotiations and climate change in general were needed in order to guarantee the usefulness and pertinence of the results. Specifically, as part of the process, it was important to remain aware of the requirements for international negotiations, for clarifying the necessary inputs and of the relevance of the activities and results to the project mandate. The mandate plays an important role in maintaining clarity on the developments and scope of the project, but one person was needed to be in charge of monitoring a connection to the original questions directing the project so that its goals are met in full and within the proposed timeframe.

The research team operated as partners to the sectorial consultants, who conducted studies to estimate baselines, to define and evaluate mitigation measures and build scenarios. It also took responsibility for integrating the results and ensuring the necessary consistency for integration. According to the interviewees, the role played by the research team was critical to the project success.

The interviewees recognized the professionalism of the members of the research team and the high standards they set for the consultants, stating that they felt 'the pressure of there being a person who would review the reports in detail and who was an experienced consultant', as well as the amount of time dedicated to monitoring and evaluating the consulting processes. This, according to public sector interviewees, differs from the way that the state generally coordinates studies and consultants, as usually the technical partners lack the time and expertise to supervise the studies. One consultant reflected this situation saying that 'generally I am contracted as an expert and therefore my counterpart is interested in the recommendations I make. In this case, I had a person who reviewed everything to the last detail and continuously questioned the methodological decisions and results, thereby collaborating continuously in improving the work' (interview with consultant).

### 4.2.1 To Deal With Uncertainty

The modelling of GHG emissions for the long term posed significant methodological and technical challenges for the project management, particularly the estimation of GHGs for 2050, which required critical sectorial information to ensure project success. On the one hand, it was important to have complete and robust sector-level databases, and ideally time series so that trends could be identified. On the other hand, it was necessary to formalize validated assumptions in order to make projections and clarify entry-parameters for modelling. Finally, it was necessary to define a sensitivity analysis, which would address uncertainty associated with long-term modelling and the specific conditions of climate change and potential mitigation measures.

Based on this, since the MAPS project was formulated in South Africa, it has emphasized the construction of scenarios for informing decision-making. This made it possible to keep the task of constructing and evaluating of alternatives within the project scope, and in the political arena, the evaluation of the options according to different criteria, priorities and conditions aside from scientific evaluation. In the same vein, the proposed methodology incorporates expert judgment to identify validated sources of information and to supplement limitations created by a lack of secondary information, which is a typical condition across developing countries.

At the same time, the method opened up the exercise of scientific modelling to experts, thus giving transparency and also sharing the process of defining the assumptions and entry-parameters of modelling with researchers and interested stakeholders using the best available information.

In this vein, the Ministry of Finance made its growth projections available for validation by the Scenario Building Team members. The working teams, consultants, Scenario Building Team and Technical Working Groups discussed the projections – at different stages of participation with consultation – and proposed technology-penetration rates that they considered technologically, politically and economically feasible in the long term, and submitted information on the potential investment and operational costs associated with the mitigation measures.

As a result, the combination of input from experts and the information generated by consultants made the results of the estimates more robust – considering how difficult it is to make long-term projections and particularly in a country with insufficient and low quality data for making successful projections (interview with research team member). Further, incorporation of the expert and technical input of the researchers and consultants made it possible to identify the parameters for including sensitivity in the estimates, those that account for the uncertainty related to modelling.

The process of consultation and formulation of information during the project was organized as follows:

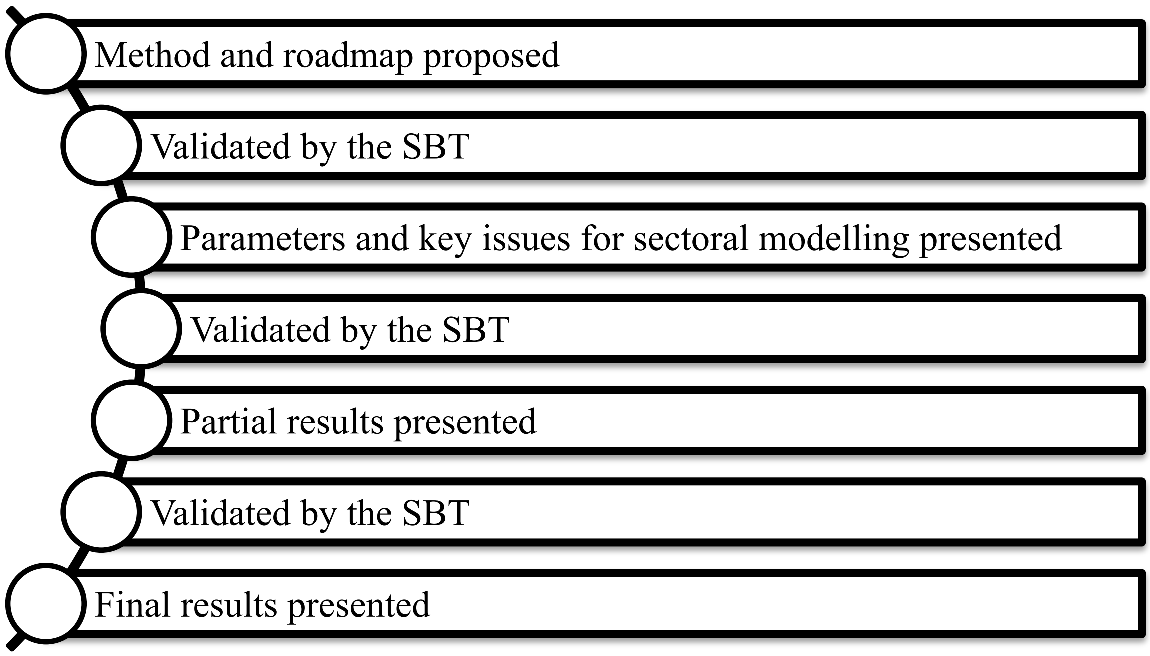


Figure 2: MAPS project work sequence

There are two aspects of this sequence that need to be highlighted. Firstly, for all discussions the executive team always made a proposal or a clarification on the topics that the Scenario Building Team could or could not rule on. Secondly, the issues that the Scenario Building Team could address and decide on were relevant topics in that they directly influenced the quality of the results (assumptions, baseline data, methodological definitions, parameters etc). As such, the conversation dealt with technical and clearly delimited topics, while, at the same time, the conversation was relevant in that the participants effectively influenced the final results of the process and validated the process.

## 4.3 THE PARTICIPATORY PROCESS

The active participation of so many people is recognized as an achievement, expressed in these words: 'Contributions by participants were considered without hindering the pace of progress and the achievement of results. Participation was particularly broad and managed to remain focussed on the achievement of goals and results.' Although the participants had high expectations of the project, it was widely agreed that the participative process adequately clarified the scope of the exercise and its results. For the majority of participants, based on its design, the project was realistic and it was clear from the beginning that, while it would provide key inputs for decision-making on climate change, the results would not be binding for political decision-making. According to interviewees, their expectations were met and properly managed by the head of processes in his role as facilitator.

The participatory process was initially conceived of as providing support to the research team on decisions over design, implementation and monitoring of participatory stages. It was proposed that the Scenario Building Team would contribute information, experiences and key opinions and that the final decisions would always be proposed by the Executive Committee and approved by the Steering Committee. At the same time, an additional component considered was of creating awareness and knowledge on climate change, expressed as 'fertilizing the ground' for installing and implementing the mitigation measures.

Criteria for membership of the Scenario Building Team were defined as follows:

To facilitate generation of information based on expert perspectives – assessed in terms of their knowledge of or experience with climate change on issues of mitigation, adaptation, emitting or absorbing sectors, co-impacts, technologies, sectorial knowledge and access to information.

To facilitate a purposeful creation of solutions based on individual involvement: the invitation to participate was on a personal basis and not as representatives of an institution or sector; the strategic thinking of the participants and their acceptance of the 'rules of the game' were evaluated positively.

During the phase of defining which stakeholders to invite to participate, the question was raised of whether to incorporate NGOs in the exercise and it was finally considered necessary to invite individuals from this sector who complied with the criteria stated above in order to validate the knowledge they could contribute, the information they could access, and the diversity they represent in terms of the predominant opinion among the public sector and academia. In addition, the legitimacy, credibility and relevance they contributed to the project were considered.

One of the main challenges that stand out concerns the conformation of the Scenario Building Team and the technical working groups. In terms of political representation, the project lacked the capacity to actively involve the main heads of the civil society organizations that were strategically identified for the project development. Lack of participation by NGOs was seen as reducing the legitimacy of the final results, a criticism mainly made by the project implementers. This affected the project stage of disseminating the results, in which NGOs highlighted project results in a biased manner.

The lack of active NGO participation also compromised the quality of results since their views were not included as part of the (contextual) information. Even though funds were made available to finance independent professionals, according to the head of processes, NGOs are under greater pressure in terms of time and resources which makes it difficult for them to participate in a project with demands on time commitment and which cannot clearly define its capacity for influencing policy. NGOs were more concerned with more immediate action and less with long-term discussion and planning. This aspect of participation is critical and strategies must be developed in future to ensure sustained participation of civil society representatives.

The member composition of the Scenario Building Team and the technical working groups needs to be improved regarding technical abilities. Although the value of the information generated through expert perspectives is recognized, there was also a technical shortfall due to a lack of experts able to identify and resolve critical issues and information relevant to the project. It is therefore necessary to be more selective of the participants, considering in a more flexible manner the incorporation of people with the knowledge and competence required for the project development and to integrate other mechanisms of consultation with experts that can strengthen the work – such as conducting personal interviews.

It is important to highlight the impact of the interests and positions of people involved in the process on the final results. Scenario Building Team members validated the mitigation actions in discussion, and provided information about feasibility based on technical but also political considerations. Key industrial and economic associations participated actively, like the representatives from the Mining sector and the representative of the electricity generation industry. The former hired a consultant to fully check the sectorial analysis and results making explicit the potential incidence of the results on informing public policy, the later contracted an international consultancy firm to carry out a set of studies on the same topic to compare the MAPS results. Both sectors, which are part of the most important emitters of CO2 in the country, participated actively in the process, making explicit their positions. To balance their particular positions, it was relevant the strategy of building scenarios and the inclusion in the participatory process of academics and representatives of alternative industries like experts on renewable energy and the director of the non conventional renewable energy.

Even though the participation looked for guaranteeing fairness, creating a constructive and creative atmosphere and preventing and managing conflicts. The position of interests of the people is crucial in this process. Therefore, it is critical to facilitate inclusion of the most diverse and innovative mitigation actions into the analysis from additional resources and using methodologies beyond the priorities set by the stakeholders. In this sense, the standards set by comparative studies, the references of international agencies and the results of the studies to address climate change from international institutions as Deep Development Decarbonization Pathway (DDDP) and others, open up the alternatives and legitimate the inclusion of diverse mitigation actions into the pool of alternatives to be evaluated.

# 5 MAIN CONTRIBUTIONS OF THE PROCESS OF CO-PRODUCING EVIDENCE

According to the interviewees, the main contributions to the project and to its design (which included a process of multi-stakeholder participation integrated with research on climate change matters) are as follows: Improvement Of The Quality Of Scientific Research, Enrichment Of Contextual Information For Public Decision-Making

## 5.1 Opening Up The 'Black Box' Of Modelling,

Assumptions, definition of parameter and methodological decisions usually stay in control of the individual definitions by the researcher: For the majority of interviewees, the results generated by MAPS have been significantly enriched by being developed in a collaborative way, integrating the experiences of researchers (the research team and consultants), expert perspectives of the Scenario Building Team and political validation by the Steering Committee and representatives of the Ministry of Environment. The exercise of collaboration and co-production is understood as a process of making explicit the assumptions and using different perspectives, disciplines and body of knowledge to build them, questioning data (quality and availability) and making explicit the scope and limitations of the methods used. This, according to interviewees, increased non-experts' understanding of the limitations and opportunities that sectorial and macroeconomic modelling offers and also provided credibility and validity to the results, while recognizing the levels of uncertainty that prevail in the results. In addition, this method provided procedural legitimacy to the results. Results were obtained through inputs, assumptions and data that were agreed upon throughout the project process, never giving precedence to anticipated results. In this way, the consensuses reached at each stage of the process protected the results from manipulation and modification. The project managed to validate intermediate decisions and create legitimacy and validity of results through reaching agreements.

The process of co-production of knowledge also facilitated social learning through the inter-disciplinary and multi-sectoral formation of the working and advisory teams. Role players across sectors valued the chance to learn from their colleagues at the meetings, increasing their awareness about the complexities of the phenomena and enriching their understanding of the topics. At the same time, they praised the opportunity to understand the inter-relations between different sectors and the challenging task of coordination and integration that many mitigation actions will demand. This opportunity for learning was a key incentive for the people to participate along the process.

The process of integrating research through modelling, through participation of experts and through broad connections with the public sector facilitated a ‘socialisation’ of complex results – the term ‘knead awareness´ was used by the interviewees through the project. In contrast to the traditional process of conducting studies through consultants, the MAPS project does not value only the final result but also the lessons learnt along the way, which include ‘the opportunity to learn about the dynamics of other sectors’, ‘the opportunity to find complementarity with other colleagues and topics’, ‘the opportunity to learn from methodological tools’.

## 5.2 Increasing The Pertinence Of Results

Integration of local knowledge through local experts and researchers made it possible to include in the exercise, in the best possible way, the micro-dynamics of the sectors, a better understanding of the productive structure in the country for emission estimations, and a better understanding of the technological conditions and preferences. In particular, the discussion on the penetration rates of measures and the identification of the measures themselves is valuable in that it was held between individuals directly involved, as opposed to external stakeholders who would be out of touch with the reality of the country. However, issues relevant to the discussion could not be dealt with in as much depth as anticipated – whether because of the makeup of the consulting groups (Scenario Building Team, Technical Working Groups) or the availability and quality of the discussion on a national level on issues associated with the availability of experts, such as in the waste sector.

The process of iteration between proposals of ‘what/how’ put forward by the research team with contributions by the consultants and technical working groups, feedback from the Scenario Building Team members, presentation of preliminary results, feedback and presentation of final results generated a peer review community where the assumptions, methods and results were subjected to public scrutiny by any interested stakeholders at many stages. This activity met with resistance from some stakeholders, particularly the consultants whose work was exposed to public review. However, they revealed in interviews that they valued the final products because the results had reached a wide audience, had been validated and had been strengthened through the process (Interview with MAPS consultant, 2014). According to the researcher, leadership of the research process by academics at the universities contributed to improving the process of review and validation of results by the mere fact that peer reviewing is at the heart of academic scientific research, in which studies are published in journals or presented at conferences. The scope and depth of the peer reviews is questionable, however, since the level of involvement of the consulting groups varied. Despite a high level of participation, detailed reviews of the CAPEX and OPEX studies were generally fewer and, in fact, the results were validated during meetings where the quality of the research team was relied on.

## 5.3 Strengthening personal and institutional capacities

One thing agreed by the interviewees from all three countries is the contribution of conducting domestic research to domestic capacity building. Even though international consultants could have performed the studies, the final impact would have been less relevant for the country. It is worth understanding that, based on the MAPS experience, while the numbers can get outdated; the technical and methodological capacities contribute to building more knowledge in the future. Chile demonstrated its capacity at the national level to perform the research, but most importantly, it has achieved the capacity to improve its results in the future based on the knowledge and experience achieved.

Not all institutions involved in the process had previous experience with Climate Change research. They therefore used their former knowledge applied to other research areas to estimate GHG emissions. It was undoubtedly a new research topic for an important number of researchers involved in the country. A positive spin-off of the MAPS experience has been the development of individual and institutional capacities mainly by local, private consultancy firms and universities that participated as researchers. The development of the project offered stakeholders and researchers the opportunity to learn about new methodological approaches, intersectoral interactions and the micro dynamics of the different sectors through the collaboration between researchers and stakeholders as members of the advisory and technical groups.

In this transition from research results toward the policy-making process, the process of co-production of evidence was crucial to improving outcomes. The research team relied on their experience and the results to respond rapidly to the policy demands. In this process the level of knowledge achieved by the domestic research teams was critical, as well as by the policy-makers responsible for defining the INDC at the different countries. In Chile, the technical and political teams that participated in the definition of the INDC knew the results and process of the MAPS Programme, which facilitated the credibility of results and the coordination to generate the necessary revisions that allowed delivering evidence useful for the kind of challenge posed by the international negotiations on Climate Change. Perhaps the most representative case is Chile, where the committee for defining INDC corresponded almost exactly to the Steering Committee of MAPS-Chile, facilitating the translation of results, the understanding of its implications and the awareness about the limits, uncertainties and opportunities provided by the evidence generated.

In turn, the impact on institutional capacity building at the public sector was less relevant than the impact on personal capacities and research capacities at the country level. Firstly, the project has made methodological contributions that strengthen the capacity and knowledge for addressing the discussion on climate change in the country. The interviewees reported having used methods they had learnt in other consultations and governmental projects. Secondly, the project contributed to improving availability and to 'socialisation' of better sources of information and methods for estimating emissions and evaluating mitigation measures. Lastly, through the project, participants learnt and integrated in their practices a different approach to evaluating the possibilities for integrating science and multi-stakeholder participation for decision-making. With reference to this, note the methodological transfer between MAPS and the long-term planning exercise being developed by the government via the Ministry of Energy. Although it is a different exercise, there are principles, methodological design and processes aspects that strongly resemble the MAPS project and which include participants holding different roles in the project who recognize the influence MAPS has had on formulating this project.

The project in general faced difficulties in the process of transferring the models and the knowledge to update the information and run the models without the support of the researchers outside of the state. It was possibly a lack of planning, timing issues and in some cases, lack of interest from the public sector or researchers. The fact is that the Chilean government will have difficulty replicating the studies performed by the MAPS Programme without the support of the researchers; even performing simple tasks that might facilitate the update of results. However, there was an important contribution for policy-makers in their awareness and understanding of Climate Change drivers, the complexity and uncertainties of the phenomena and mitigation actions.

# 6 MAIN CONCLUSIONS: LESSONS LEARNT AND FUTURE CHALLENGES

The role of evidence in the policy-making process has been discussed extensively by social scientists (Shackley & Wynne, 1995; Walker, 2000; Davies, 2005; Judge & Bauld, 2001; Cable, 2003; Sanderson, 2006). While some researchers argue from a normative standpoint about the relevance of using evidence to support public decisions, others emphasize the lack of relevance of scientific evidence for the policy-making process because of the prevalence of ideologies, interests and values. In this paper it is argued that a key element to take into consideration in the policy-making processes and relevant social transformations, is not only about the quality of the results, but also about "the way we do things" as a critical dimension. This means, understanding the science and policy relationship as a social process where the methodologies applied (what kind of information is used, who and for whom the results are built and the kind of personal and institutional relationships we create) are critical issues to maximize the contribution of evidence to inform public policy. These basic concerns are particularly relevant for building evidence for Climate Change in developing countries.

Generating evidence to inform Climate Change policies based on a process of co-production of knowledge has meant an important contribution to the robustness of results and capacity building, both at the individual and institutional level. The evidence generated by the studies has been crucial for defining the INDC in the country making explicit its influence in the policy-making process.

At the same time, the experience has shown that quantitative results become obsolete very fast, faster than we expected. Changes in relevant parameters and the intrinsic limits of making projections in the long run can affect the credibility of results. Therefore, production of evidence can only make a very specific contribution in the short term. It must be understood as a process, whose ultimate purpose is to contribute to social learning mediated by the development of domestic institutional capacities. In such a dynamic and uncertain exercise, specific numbers become redundant, while methodologies and learning remain and allow countries (as in the case of Chile, Colombia and Peru) to build upon their results and respond timeously to specific challenges (like informing the definition of the INDC).

Finally, the question about continuity remains open. It is arguable that the contribution of the MAPS approach in terms of building reliable quantitative results together with building institutional capacities is an important starting point that might facilitate the discussion and implementation of mitigation actions across countries in the years to come. Also, it is probable that some of the people who participated in the process will continue to be interested in working on Climate Change issues or, at the very least, integrate mitigation to evaluate their projects. This will be more likely if the international agenda on Climate Change increases the urgency for countries to act and foster more ambitious mitigation targets. External drivers such as international pressure for global Climate Change negotiations and international finance will remain relevant in the following years. What is probably true is that all these potential situations in the near future might increase their probability of occurrence because the process of building evidence has been governed and developed with domestic capabilities by national researchers and stakeholders.

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