LA POLÍTICA DE TRANSICIÓN ENERGÉTICA DE COMBUSTIBLES FÓSILES A ENERGÍAS RENOVABLES: EL CASO DE ARGENTINA, BRASIL Y URUGUAY EN EL PERIODO 1970-2016

ENERGY TRANSITION POLICY FROM FOSSIL FUELS TO RENEWABLE ENERGY: THE CASE OF ARGENTINA, BRAZIL AND URUGUAY IN 1970.2016 PERIOD

María Florencia Zabaloy[ϖ]

Carina Guzowski[κ]

- **ABSTRACT:** New and Renewable Energy Sources (NRES) have an essential role in the energy mix because the energy sector is one of the main responsible of the Greenhouse Gases. At the same time, the introduction of these energy sources has a positive impact on the national energy security because it reduces the dependence on fossil fuels. This paper examines the effectiveness of the main public policies that introduce NRES in three countries of Latin America: Argentina, Brazil and Uruguay, since 1970 to 2016. The results show that in this period Argentina has had a low performance in these policies in comparison to Brazil and Uruguay, due to regulatory and economic barriers regardless of the economic instruments implemented.
- **KEY WORDS:** Energy Resources, Alternative Energy, Sustainable Development, Energy Planning, Developing Countries.

- **RESUMEN:** Las Fuentes Nuevas y Renovables de Energía (FNRE) poseen un rol esencial en el mix energético ya que el sector energético es uno de los principales responsables de los Gases de Efecto Invernadero. Al mismo tiempo, la introducción de estas fuentes energéticas puede mejorar la seguridad energética nacional, al reducir la dependencia de los

[ϖ] Departamento de Economía, Universidad Nacional del Sur, Argentina; CONICET. E-mail: florencia.zabaloy@uns.edu.ar

[κ] Departamento de Economía, Universidad Nacional del Sur, Argentina; Instituto de Investigaciones Económicas y Sociales del Sur (IIESS) (CONICET-UNS). E-mail: cguzow@criba.edu.ar

combustibles fósiles. Este trabajo analizó la efectividad de las principales políticas públicas que introdujeron FNRE en tres países de Latinoamérica: Argentina, Brasil y XUruguay, desde 1970 hasta 2016. Los resultados demostraron que Argentina en ese periodo ha tenido un bajo desempeño en este tipo de políticas comparado con los casos de Brasil y Uruguay, debido a la existencia de barreras económicas y regulatorias, independientemente de los instrumentos económicos implementados.

- **PALABRAS CLAVE:** Recursos Energéticos, Energías Alternativas, Desarrollo Sustentable, Planificación Energética, Países en Desarrollo

- **CLASIFICATION JEL:** P48, Q28, Q42, Q48.

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I. Introduction

Since several decades the world acknowledges the importance of energy for socioeconomic development. This is due, on the one hand, to the fact that energy is a growth driver. The lack of energy supply has direct impacts (real), because without energy it is not possible to develop economic and productive activities, due to the known relation between energy and economic activity (Saidi et al, 2017; Zhixin Xin, 2011); as well as indirect impacts (monetary) as a consequence the fluctuation of energy price effect on the economy, since change in energy consumption in contexts of energy price volatility affect strongly to the economy (Recalde, 2012). Monetary impacts are related to the increase in energy prices, thus national income has to be reassigned from other productive activities to the energy sector in order to pay the higher energy bill (Hall et al., 2009; Murphy y Hall, 2011), which is more serious in energy importer countries.

On the other hand, the economic relevance of energy is associated with its importance for social development. Access to modern energy services for cooking and heating, such as electricity access, improves the health and education conditions of the population, which have a direct impact on human capital development. Moreover, energy has an indirect impact on poverty given that energy bill could represent a high percentage of the budget of the families (Saghir, 2004). Nonetheless, according to the International Energy Agency (IEA), at the present 1.2 billion people continue without electricity access (IEA, 2016)[†].

In Latin America according to REN21 (2017) 95% of the population has access to the electricity grid, however around 22 million people in Bolivia, Colombia, Guatemala, Haiti and Nicaragua do not have access; while around 14% of population (65 million of people) have no access to clean energy for cooking, with its consequent impact on health.

In the last decades, in addition to the recognition of these aspects, the importance of the environmental impact of energy consumption begins to take place. The energy sector is the main responsible of anthropogenic emissions of Greenhouse Gases (GHG), in particular it represents two-thirds of global anthropogenic emissions (OECD/IEA, 2015). In this context the need for an energy transition towards low-carbon solutions seems to have increased, and also has increased the relevance of the energy transition policy. In a general way, many authors define energy transition as structural change in the way energy services are delivered and used (Rosenow et al., 2017). This definition implies the need of actions on both supply and demand sides of the energy systems. Thus the transition to a more sustainable energy system

[†] See: http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/

requires a much faster development of new and renewable energy technologies for electricity generation (Bersalli, 2017).

In the actual context of environmental deterioration and over-exploitation of natural resources, New and Renewable Energy Sources (NRES) have a key role in reducing the greenhouse effects generated by the use of conventional energy sources, in achieving energy self-sufficiency and in diversifying the energy matrix (Recalde, 2017).

In reaction to this situation, many developed countries carried on different energy policies. One of the key targets of these policies has been to increase the share of NRES, in their different forms, in the energy mix. Nevertheless, the situation has been, and remains, different for developing or underdeveloped countries. In these cases, in spite of their natural endowment of renewable sources of energy, institutional, economic and social features may have retarded the use of energy policy and, therefore, the inclusion of renewable enrgy in electricity mix, except for big hydro plants. This may be the case of the Latin American region (Recalde et al, 2012).

The debate about energy policies has a relevant place in the governments of the different countries of the world because the promotion of the NRES is a crucial point to achieve a sustainable development. Argentina has a primary energy matrix highly dependent on fossil fuels. Therefore the national authorities have already begun to promote policies that include renewable energy, as well as other countries from the region.

The problem observed from this research work is that in Argentina there have been many policy instruments to promote NRES energies, nonetheless there is not yet a great share of these energy sources in the power generation mix. In order to study this problem, it is useful to compare the experience of other

similar countries, that is, countries with similar energy markets, cultures and resources, among others. For this purpose we selected Brazil and Uruguay.

In this context, the objective of this paper is to examine, from a historical point of view, the effectiveness of the main public policies that introduce NRES in three countries of Latin America: Argentina, Brazil and Uruguay, since 1970 to 2016. This paper carries out a comparative study between these policies, not only to compare the results achieved but also the design and the implementation.

The hypothesis raised in this research is that the policy designs for NRES are very similar in the three countries under study; however the results, in terms of policy success, were different. If the hypothesis is confirmed, we will explain why similar policies led to different outcomes.

The paper is organized as follows. Section 2 introduces the theoretical framework that will be used in order to do carry out the study proposed and presents the definition of the NRES and the principal instruments to promote then. Section 3 briefly describes the energy matrixes of Argentina, Brazil and Uruguay using statistical information and indicators. Section 4 examines the main public policies for renewable energy in each country. Section 5 presents the comparative study between the different countries. Finally, section 6 presents conclusions.

II. Methodology

The approach of this paper is centered in a systemic, dynamic and multidimensional perspective, in which energy is considered a key factor for the economic development of the country. Under this view the energy sector is considered as a subsystem of a larger system, defined by different

dimensions, such as, social, economic, political, cultural, and others (Bouille, 2004). As energy satisfies primary needs it is considered a social good because it is essential for the wellbeing of the population (Guzowski, 2015).

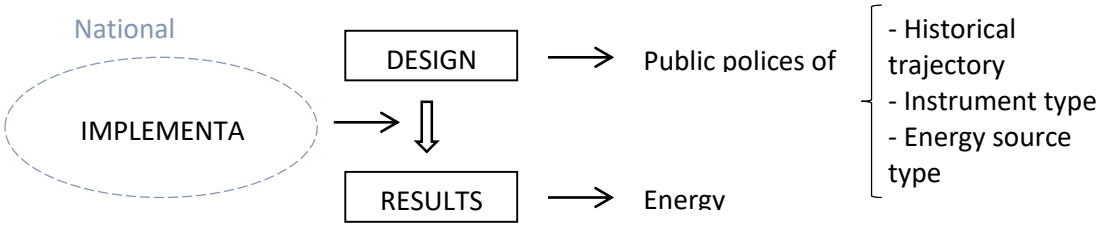
Huaylupo (2007) states that economic relations are part of a greater totality, which defines its existence, functioning and recreation. In other words, the author also recognizes that there are other dimensions, such as social and environmental context, to be consider when an economic analysis is carried out. In fact, the energy system interacts with different dimensions, namely the economy, society, the natural environment and the political level. These interactions are so relevant that energy policies, which aim to promote sustainable development, must necessarily have a systematic nature (OLADE/CEPAL/GTZ, 2000, p 84).

Another central issue when studying energy policies is the importance of energy planning, and therefore, the importance of the Government in this process. The complexity of energy, not only in its technical dimensions but also in sociocultural, geopolitical, economic and environmental dimensions, generates a need for intervention of public authorities in energy systems (Abadie et al, 2017, p 3). This is reinforced by the fact that energy has a double dimension, that is, it is a strategic good but at the same time it has the nature of public service (Abadie et al, 2017; p 4).

Under this framework, the methodology consists in the analysis of the design and results of the NRES polices, as indicated by Figure 1. In order to analyze the design we need to examine reports and public documents on the legal framework, such as laws, resolutions, national plans, etc. From those documents we can determine the historical trajectory, the main instruments used and the targeted energy sources. How polices are designed influenced the results, which can be assed studying the energy matrix from data available

from national energy ministries and secretaries. At the same time, the national context, such institutional and political conditions influence the implementation of the policies, which in term affects the outcomes.

Figure 1: HOW TO ANALYSE PUBLIC POLICIES FOR THE PROMOTION OF NRES



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In other words, the methodology, on one hand, consists in reviewing all the policies to promote NRES from 1970 to 2016 in each country, highlighting which instruments were used and which NRES were promoted. On the other hand, it consists in analyzing relevant energy indicators. Finally, the comparative analysis is carried out in two different ways: first we compare the design and results of the policies at a country level and second we compare at a global level which countries had a better performance.

Before moving on to the next section there are some key concepts that we need to define. In that sense, the International Energy Agency defines renewable energy as "energy that is derived from natural processes that are replenished at a higher rate than they are consumed. Solar, wind, geothermal,

hydropower, bioenergy and ocean power are sources of renewable energy" (IEA).

Moreover, the IEA classifies the renewable energy sources according to their technological development in three generations. The 1st generation includes the renewable sources developed since XIX century, such as large hydroelectric power plants, biomass combustion and geothermic energy. The 2nd generation includes the ones that have been developed since the eighties, that is to say, wind energy, biofuels, solar collectors and photovoltaic solar energy. At last, the 3rd generation gathers technologies that are still developing, such as oceanic energy, solar concentrators, improved geothermal systems and integrated bioenergy systems. The 2nd and 3rd generations are called the NRES (new and renewable energy sources) (IAE).

Regarding the instruments used in public policies for promoting NRES there is not a unique classification of then. In this paper, it is considered the classification proposed by Recalde and Guzowski (2012) and Bersalli et al (2015). According to these authors, the instruments are classified as follows:

- Regulatory instruments
    - Quantity Systems or Renewable Portfolio Standard (RPS)
    - Net Metering (NM)
- Educational policies
- Voluntary instruments
- Economic instruments
    - Feed- in- Tariff (FIT)
    - Feed-in Premium
    - Bidding system
    - Quantity System with Negotiable Green Certificates
    - Research, Development and Innovation

- Fiscal Incentives
- Investment Subsidies

Regulatory instruments are guidelines that define boundaries and compulsory standards for certain technologies. In fact, RPS and NM are included in this group. The NM consists in measuring the electricity flow between a client, provided with a personal renewable system, and the electricity distribution grid. When the client's consumption is higher than his own generation, the grid provides him with energy. Otherwise, when the client's generation is higher than his consumption, the surplus is injected to the grid. Hence, under this system the customers pay for the net electricity used (Kindermann Bassano, 2012).

Educational policies that aimed to spread the new technologies are also considered promoting instruments. In addition, voluntary instruments are mechanisms that are based on the voluntary commitments of those who participate in the agreement, such as producers, distributors and consumers. Finally, economic instruments aim to improve renewable energy competitiveness affecting energy prices or costs (Bersalli et al, 2015).

Within economic instruments can be mentioned the FIT scheme. It consists in determine a fixed price, express in domestic or international currency by kWh or MWh during a certain period of time, to electricity generators (Recalde y Guzowski, 2012). In this case, there is not a relation with market prices due to the fixed tariff established in the contract (Bersalli et al, 2015).

The Feed-in Premium is very similar to former but has its particularities. In this case a premium on top of the market price is paid to electricity generators. Thus, tariffs are correlated to market prices as they are determined as a percentage or a fixed amount on top of the market prices (Bersalli et al, 2015).

Under a bidding system the electricity market regulator determines that a certain amount of electricity must come from renewable energy and organizes a tender so that generators compete for the energy allocation (Bersalli et al, 2015). Consequently the government gives a subsidy to the lowest price per kWh.

In a Quantity System with Negotiable Green Certificates the national government defines a Renewable Portfolio Standard that the electricity distributors must obey, that is to say, a certain amount of Negotiable Green Certificates per year that corresponds to a certain percentage of their electricity sells. Each MWh of energy generated from NRES creates a certificate which is assigned to the generator and he can sell it to the distributors. As a result, the energy producers benefit from electricity market price and the Negotiable Green Certificates market price (Bersalli et al, 2015).

Finally, there are a group of economic instruments in which the government has a direct intervention that is Research, Development and Innovation, Fiscal Incentives and Investment Subsidies.

According to the international evidence, the Feed-in system seems to be the most effective instrument (Recalde and Guzowski, 2012). Kozulj (2010) also agrees that the Feed-in mechanism is the most efficient. However the author states that its effectiveness depends on the mode of implementation rather than its intrinsic characteristics.

III. Results

Energy matrixes and energy indicators

This section presents the analysis of the primary energy matrix of Argentina, Brazil and Uruguay since 1970 to 2016, made from the data of national energy

balances, in order to detect the most significant changes during the period. At the same time, this section presents other relevant statistical information to understand the particularities of each energy sector.

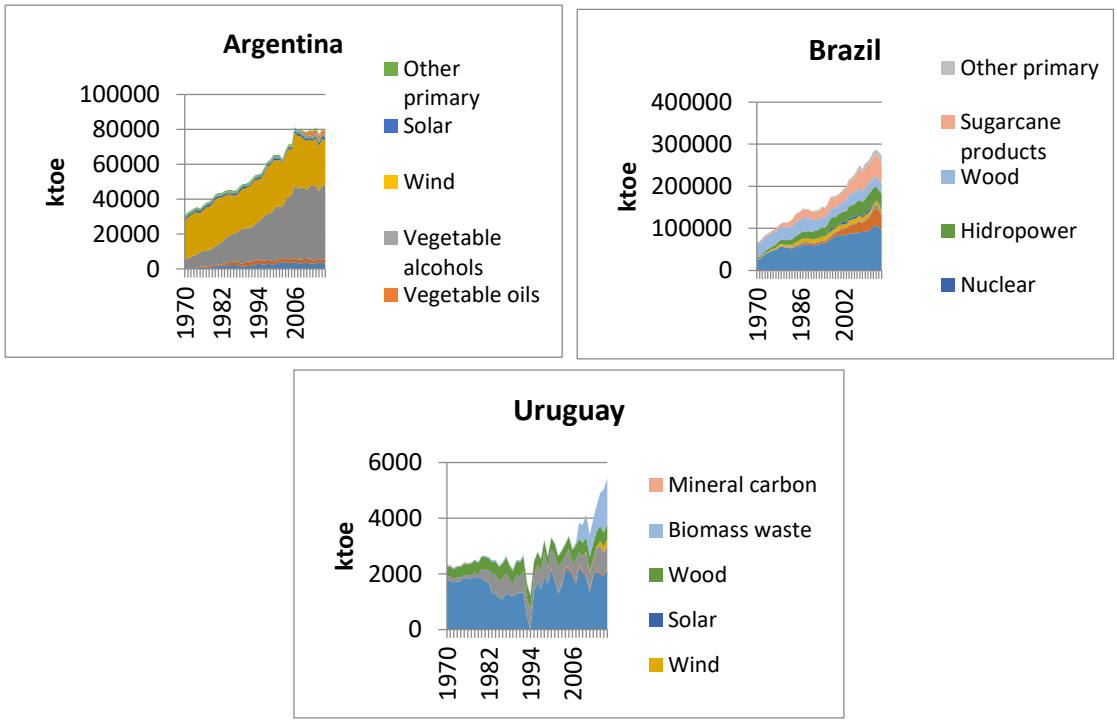
Figure 2 shows that Argentina is highly dependent on fossil fuels, such as petroleum and natural gas. Argentina is a very *thermoelectric* country. In fact, there has been a predominance of oil and derivatives share until the middles of the seventies. From then on, hydroelectric power and natural gas have relatively substituted oil because they were more abundant and cleaner energy sources (Guzowski, 2006).

In this context, Argentina was one of the leading countries of the region, and the world, in reforming the energy sector. The energy restructuration processes initiated in the late 1980s and early 1990s. This period was characterized by market based reforms in accordance to the "Washington Consensus," not only in Argentina, but also in the majority of Latin American countries. For the majority of LAC these reforms implied the change from "*Central Control*" (CC) to "*Open Market*" (OM) with total or partial transfer to private actors or the maintenance of integrated public companies with the inclusion of private agents and new regulation institutions and organizations (Recalde and Guzowski, 2012).

During the nineties, the relevance of natural gas increased in the electricity generation due to thermic generation low cost in comparison to hydropower, less environmental impact than other energy sources, improvements in natural gas transport and distribution and technical innovations in combined cycle plants (Guzowski and Recalde, 2008; en Recalde 2011). In addition, we see that Argentina does not present a diversify energy matrix. Nonetheless since 2014 wind and solar energy are included separately from the item "Other primary". Consequently, there is a tendency to diversification but is very

scarce. Brazil has a highly diversify energy matrix and an appreciable renewable energy share. As we can see in Figure 1, sugarcane products and hydroelectric power shares have been relevant since mid-eighties. However, during the last two decade there has been an increase in the non-renewable energy, such as natural gas. In fact, natural gas share has enhanced due to the fact that after the 2001 crisis fossil fuels share increased in the electricity generation park.

FIGURE 2:
PRIMARY ENERGY MATRIX EVOLUTION 1970 - 2016
(in ktoe)



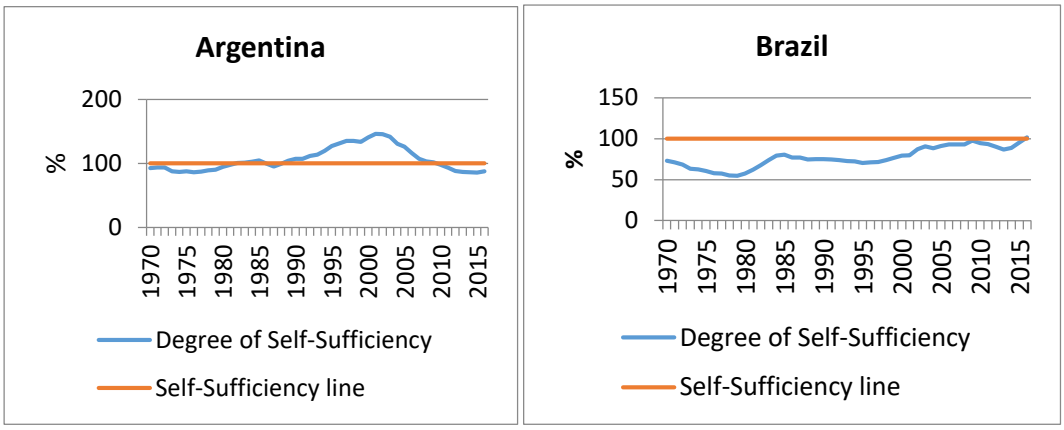
Source: own elaboration based on National Energy Balances.

In Figure 2 we can see that Uruguay has a high petroleum share during the entire period under study and, to a lesser extent, an important wood fuel share.

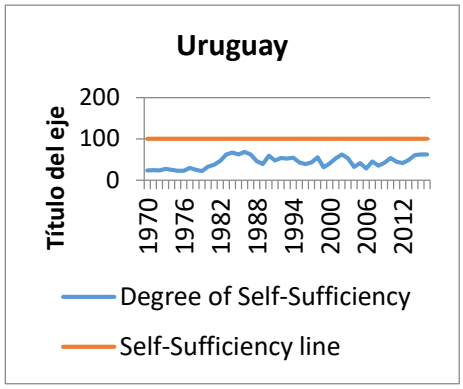
However, since the eighties hydropower energy has a more relevant share. The matrix shows significant changes in the last ten years. We can see that several energy sources have been incorporated such as natural gas, even though its share is minimal, biomass waste, solar energy and wind energy. The remarkable increase in energy supply from biomass waste is explained by the energy generation of UPM-Botnia Company from the paper industry. In addition to the energy matrix analysis we can study the degree of self-sufficiency‡ for each country. This indicator shows the percentage of the energy required by the country that comes from own resources. Figure 3 shows the evolution of this indicator in the period 1970-2014 for the three cases.

FIGURE 3: EVOLUTION OF SELF-SUFFCIENCY DEGREE 1970 – 2016

(in percentage)



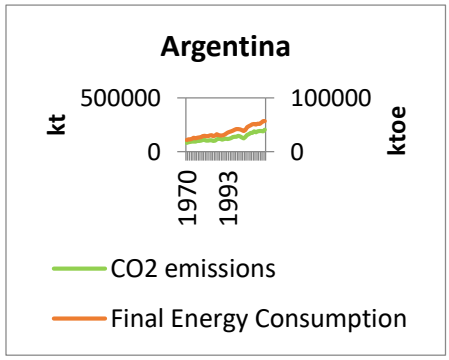
‡ For the methodology see Recalde, M. (2012) "Importancia del autoabastecimiento energético: Impactos directos e indirectos sobre el crecimiento", in Revista Ciencias Económicas 30 (1), enero-junio 2012, 87-107 (ISSN: 0252-9521).

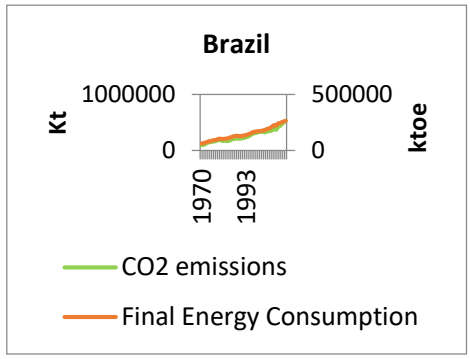


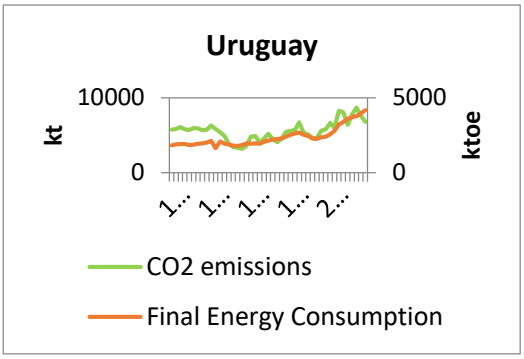
Source: own elaboration based on National Energy Balances.

During the seventies Argentina was an energy importer. In 1982 it achieves self-sufficiency, which is remarkable since it is the only country under analysis that has reached at some point the goal of self-sufficiency. From then, the indicator increases until it reaches a maximum level in 2001, from which it begins to decrease steadily and in 2010 loses its self-sufficiency. Brazil and Uruguay present a different evolution of the degree of self-sufficiency comparing to Argentina. During the entire period neither of the countries achieve self-sufficing. Uruguay is a very dependent country, in particular it depends on oil, natural gas and electricity importations (Bertoni et al, 2010). Therefore, when we analyze Figure 3 we see that the indicator has very low values. Nevertheless, in the last years it is increasing.

FIGURE 4:
ENERGY CONSUMPTION AND CO^2 EMISSIONS
EVOLUTION 1970 – 2016
(in ktoe and kiloton)







Source: own elaboration based on National Energy Balances and World Bank.

Figure 4 shows the evolution of energy consumption and CO^2 emissions from 1970 to 2011 for the three countries. In all cases there is a high correlation between the variables. Nonetheless, Argentina y Brazil shows more correlation between the variables, which indicates that the increased energy consumption necessarily imply a higher level of CO_2 emissions. Uruguay, on the other hand, has certain points in which emissions decreases remarkably, those are: in the early eighties, in last years of the nineties and between 2008 and 2010. This could be indicating that the introduction of NRES in the national energy matrix reduced the level of emissions. However, we cannot confirm that the introduction of cleaner energy in the matrix explains the reduction in CO_2 emissions because it could be due to a cyclical change in economic activity.

Renewable energy policies

This section presents the more relevant policies to promote renewable energy in the three countries under study.

Argentina

Argentina has a relatively recent legislation to promote NRES. In fact, the first legislation was established in 1998 that is the Law 25.019 Wind and Solar Energy National Regime, in which a premium system of one cent of Argentinean pesos per kWh generated for the Wholesale Electricity Market was determined along with other fiscal incentives (Recalde et al, 2015).

In 1999 the Renewable Energy Project in Rural Electricity Market (PERMER), was launched. Its goal was to supply electricity, generated by different NRES, to people living in rural areas and a lot of public services that were outside the scope of the power distribution centers.

The first Law that established the legal framework for biofuels production is Law 26.093 Regulation and Promotion Regime for Production and Sustainable Use of Biofuels, released in 2006. This regulation established a compulsory blend of at least 5% of biofuels in diesel oil (Flexor et al, 2012). In addition, it established several economic incentives, such as early refund of value added tax, subsidies, exemption of minimum presumed income tax until the third accounting year, fossil fuels tax relief for the case of biofuels included in the compulsory blend and a record of producing plants (Chidiak and Stanley, 2009).

At the same time, in 2006, the Law 26.190 National Regime for Use of Renewable Energy Sources destined to Electricity Production was approved and replaced the previous Law, Law 25.190. The new regulation stated a quota of 8% of NRES of the total of electricity consumed to be achieved in ten years. Wind, solar, geothermic, ocean power, hydroelectric power up to 30MW, biomass, landfill gases, sewage treatment plant gas and biogas were included. It was established a remuneration of $ 0.9/kWh for solar photovoltaic generators and a remuneration of $ 0.015 kWh for the rest of

the mentioned NRES. Another incentive was the value added tax deferral on capital investment and the exemption of minimum presumed income tax (Guzowski and Recalde, 2009).

In 2009 the GENREN, a promotion program of NRES, was launched. The program consisted of the tender of 1.000 MW of electricity generation from NRES, in particular 500MW for wind power, 150MW for biofuels, 120 for solid waste, 200 for biomass, 60 for small hydroelectric plants, 30 for photovoltaic solar and 20 for biogas (Recalde et al, 2015).

The bids must have 50 MW of power modules at most. To this end Enarsa (Energía Argentina SA) convened a public tender to purchase electricity from NRES to the companies that submitted and approved projects to sell it to CAMMESA (Management Company of Wholesale Electricity Market) through supply contracts to 15 years and with price guarantee (Bondolich, 2012). In the bidding process not only was taken into account the offered price as a selection criterion, but also the investment schedule and the percentage of domestic components in investments (Recalde et al, 2015).

The economic instrument to promote NRES in the GENREN is the Feed-in Premium scheme, because a premium on top of the market price is paid. The value of the premium is $ 0.9/kWh for solar photovoltaic generators and $ 0.015 kWh for the rest of the mentioned NRES. Companies investing in this program could obtain a considerable profit, as they had secured the energy sale for the long-term and at dollarized rates (Guzowski et al, 2007).

In 2015 Law 27.191, also known as Law Guinle, was approved and modified several articles of the Law 26.190. In fact, the quota of NRES in electricity generation was set in 8% for 2017 and 20% for 2025. In order to increase the quota, in the article 8, a schedule of successive increases was established: 12% for 2019, 16% for 2021 y 18% for 2023. At the same time, this legislation

created a Public Trust Fund called "Fondo para el Desarrollo de Energías Renovables" (FODER), which will be formed as and administration and financial trust. The assets included in this trust fund will be used to loan granting and to implement and finance projects (Art.7).

Finally, in 2010 the compulsory blend for biofuels was modified through Resolution 554/2010, and increased up to 7% (Flexor et al, 2012). Later, in 2013, the Resolution 1125/2013 established a compulsory blend of at least 10% from 1st February 2014.

Brazil

The National Alcohol Program, PROALCOHOL, was the first drive of renewable energy in Brazil. The energy crisis of the seventies and the risk of collapse in sugar prices, which had reached high levels and therefore had encouraged a large investment in modernization of the sugar industry, were the factors that motivated the creation of PROALCOHOL (Rosillo-Calle and Cortez, 1998).

The program began in 1975 with a strong emphasis on replacing gasoline vehicles for vehicles that run exclusively with hydrated alcohol. In this period economic benefits and tax incentives were implemented to help establish the industrial park until 1989 (Verdesio, 2003).

Two decades later, in 1995, the Energy Development Program of States and Municipalities, PRODEEM, was created with the goal of reaching universal access to electricity for people living in remote locations. The program aimed to broaden the dissemination of renewable energy (Verdesio, 2003).

The NRES included in this project were: small-scale hydro energy, burning or gasification of biomass, wind energy and photovoltaic energy. Photovoltaic

panels were installed because it is not require previous environmental studies, the systems are standardized and they are easily installed (Verdesio, 2003).

In 2001, the government launched the Emergency Wind Energy Program (PROEOLICA). As it was an emergency program it was planned to install only 1050 MW of wind energy until the year 2003 (Schaller, 2008). This program was replaced by the Incentive Program for Alternative Sources of Electric Energy (PROINFA) in 2002, through Law 10.438. Under this regulation energy distributors were forced to buy electricity generated from alternative sources. The law established a secured electricity purchase contract for a period of 15 years. The intended goals were to install 3300 MW until 2006 (1100 MW of wind energy, small hydroelectric power plants and biomass respectively), to generate 10% of the electricity with NRES in 2014 and to install 14074 MW or 72,62 TWh/year of electricity generation with renewable energy between 2006 and 2014 (Verdesio, 2003).

In 2002 it was also created the National Program for Biodiesel Production (PROBIODIESEL), which contained social inclusion goals (Flexor et al, 2012). In addition, in 2003, flex-fuels cars were launched and had a wide costumer acceptance. Those cars can use gasoline, alcohol or a combination of both (Horta Nogueira and Silva Capaz, 2013).

Biodiesel was introduced in the Brazilian energy matrix in 2004 with the National Program for Production and Use of Biodiesel (PNPB). The foundations of the program were the insertion of family farming, environmental sustainability and economic viability (Flexor et al, 2012).

This program aimed to encourage small producers of less developed regions to produce biodiesel and to progressively determine the use of compulsory blends. It started with a mandatory blend of 2% (B2) in January 2008, which increased to B3 in July 2008 and B4 in July 2009. According to the original

legislation, in January 2013, the compulsory blend should have been of 5%, but due to biodiesel producers demands, the measure was established form January 2010 (Horta Nogueira and Silva Capaz, 2013). Since November 2014 the compulsory blend increased to 7%, according to the Provisional Measure 647.

Regarding wind energy, in December 2009, an Auction of Wind Energy was launched. This initiative establishes fiscal incentives that enabled the reduction of investment costs and the entry of new firms producing wind energy equipment (Castro et al, 2010).

At last, in April 2012, the ANEEL (National Electric Energy Agency) published the Normative Resolution 482/2012 to allow micro and macro electric generation plants from renewable sources to connect to the grid. Through this legislation the Net Metering system was established. Hydro power, solar, wind, biomass and qualified cogeneration are included (Art. 2).

Uruguay

In the case of Uruguay, the promotion of NRES begun in 2002 with Law 17.567 of Renewable Energy Promotion, which declares of national interest the production of alternatives fuels, renewable and substitutes of oil, elaborated with animal or vegetable national material. The Executive can fully or partially exempt from all taxes levied on oil derived fuels to 100% of alternative fuel produced with domestic raw material (Bertoni et al, 2010).

According to the Decree 77/006 the National Administration of Power Plants and Transmission (UTE) can issue contracts with private agents that generate energy from alternative sources: biomass, wind and small hydroelectric power plants. This regulation establishes that total projects of each energy source cannot exceed 20 MW and each project power must be lower than 10 MW.

Contracts will be stipulated for a maximum of 20 years, assuming a cost of promoting renewable sources that is transferred to tariffs (Bertoni et al, 2010).

In 2007 Law 18.195, known as Agrofuels Law, is approved, and in 2008 its regulatory Decree 523/008. The objectives of these legislations were the promotion and regulation of the production, the commercialization and the use of agrofuels in Uruguay. The law includes only alcohol fuel and biodiesel that are used in combustion engines. As these fuels are directed mainly to the transport sector, the law is addressed to that sector (Bertoni et al, 2010).

The law established a compulsory blend of at least 5% of alcohol fuel produced in the country with domestic raw materials in gasolines and a compulsory blend of at least 2% of biodiesel in diesel oil until December 2008. From January 2012 the compulsory blend will increase to 5% (Bertoni et al, 2010).

In 2009 the Decree 403 was approved. It establishes that the UTE can make contracts to purchase electricity generated from wind energy. The installed power of each project must have a minimum of 30 MW and a maximum of 50 MW, while the maximum power to hire under this instrument may not exceed 150 MW. In addition, it established that the other 150 MW, to achieve the target set for 2015 (300 MW of wind energy), will be implemented in a second stage later (Bertoni et al, 2010).

On the other hand Law 18.585 of Thermic Solar Energy Promotion, approved in 2009, declares of national interest the research, development and education on the use of thermic solar energy. The decrees 451/011 and 325/012 regulate the benefits and obligations of this law and authorize the sale of national manufactured equipment exempt from tax.

Decree 173/010, approved in 2010, enables microgeneration for electricity production from NRES including wind, solar, biomass and mini-hydro.

Therefore generators can produce their own electricity to satisfy their demand (partially or totally) and inject the surplus to the electricity distribution grid (Horta et al, n.d.).

Decree 367/010 establishes that the UTE can make especial contracts to purchase electricity generated in national territory from biomass. This regulation increases the capacity limit fixed by decree 77/006 to 20 MW with the goal of achieving 200 MW generated from biomass (Recalde and Guzowski, 2012).

Lastly, decree 159/011 aimed to accomplish the second stage of the contracts to purchase electricity generated from wind energy as planned in decree 403/009.

Comparative analysis

In Argentina one of the main incentive systems to promote NRES is the Feed-in Premium, implemented through GENREN. As mentioned earlier it is a promotion program, in which trough public tender, NRES production projects are awarded. In this case a premium on top of electricity market price is paid (Kindermann Bassano, 2012). In Argentina the premium is $ 0.9/kWh for solar photovoltaic generators and $ 0.015 kWh for the rest of the NRES.

Another promotional instrument present in the Argentina legislation is the quota system, both to determine a minimum percentage of NRES in electricity generation, 8% for 2017 and 20% for 2025, and to determine a compulsory blend, 10% of biofuel in gas oil.

One of the main programs to promote NRES in Brazil is the PROINFA. This program is based on a Feed-in scheme, in particular a Feed-in-tariff. In this case a fixed economic value is determined for each renewable source (Sergi,

2010). Thus, when the market price is below the fixed economic value, the difference is covert with a subsidy.

To clarify, in PROINFA the subsidy is variable and the price is fixed. However, in GENREN the subsidy is fixed and the price is variable (Sergi, 2010).This difference imply that Argentina presents a more uncertain scenario to make profits, whereas Brazil presents an expectation of guaranteed profit because there is a guaranteed price.

Brazil also has a quota system, both to determine a minimum percentage of NRES in electricity generation, 10% for 2014, and to determine a compulsory blend, 7% of biofuel in gas oil.

In the case of Uruguay the mechanism to promote NRES is the bidding system, regulated by the Decree 77/006. Contracts are awarded for 20 years for projects with an installed capacity lower than 10 MW, where certain investments are required in domestic capital goods and services. In this decree a quota system of 60 MW is also established. Nonetheless, according to Energy Plan 2005-2030 of Uruguay the target is to achieve 500 MW for 2015, 300 MW of wind energy and 200 MW of biomass.

Only Uruguay and Brazil have a Net Metering system. In Uruguay the decree 173/010, approved in 2010, authorizes subscribers connected to the low voltage distribution grid to install generation from renewable sources such as wind, solar, biomass and mini hydro. Brazil, on the other hand, in 2012 launched the normative resolution 482/2012, with the goal to establish the general conditions to access microgeneration. This regulation includes hydro, solar, wind, biomass and qualified cogeneration (Art.2).

Moreover, in all countries there is great concern to stimulate biofuels production. In fact, the three cases analyzed present public policies regarding the quantity (compulsory blends) and the prices (economic benefits) of

biofuels. However, the leading country in this area is Brazil due to its early alcohol productive development.

One of the essential aspects of the legislation for promoting renewable energy sources are the complementary regulations. In Brazil the same year that the PROINFA was launched the decree, 4.541, that established the rules and organization of the program was approved (Sergi, 2010). In a similar way, in Uruguay the decrees 397/007, 296/008 and 299/008 complement the decree 77/006. (Recalde and Guzowski, 2012). The Argentinean case is rather different because for a long time there wasn't any complementary legislation to regulate the NRES programs (Sergi, 2010). For instance, it was not until 2015 that the Trust Fund for Renewable Energy was regulated by Law 27.191.

Regarding the results of the public policies described we can partially analyze their performance by exploring the energy matrix presented in section 3. In that section we saw that the three selected countries have diversified energy matrixes. However, both Uruguay and Brazil have achieved greater renewable energy shares.

This analysis is in line with Kindermann Bassano´s (2012) opinion. The author states that the instruments used to promote NRES have had better results in Brazil and Uruguay, contrarily to Argentina. The author notes that when a Feed-in scheme is applied, it is essential the determination of the premium to be paid to generators.

The intention of promoting a program like GENREN in Argentina with a mechanism of Feed-in Premium is that Law 26.190, the framework for NRES development at the time, did not generate the desired results. This was mainly due to economic and financial barriers. In fact, economic incentives in Argentinean pesos were damaged by increased generation costs and by the

pesification[§] of tariffs that froze electricity prices (Recalde et al, 2015). Thus, the incentives were not attractive enough for investors. In this sense, in the Argentine case the problem was not only the implementation of the Feed-in Premiun mechanism but the institutional context mentioned above.

Despite these difficulties, with GENREN investment in energy sector is increased to some extent. In the first stage, project for a total of 895 MW were awarded. However, as the total supply was not covered, a second stage was launched to cover 1208 MW (Recalde et al, 2015). The main inconvenient of this program was the low achievement of the schedules. For instance, currently there are only three wind energy projects operating: Rawson I y II y Loma Blanca IV. This is explained mainly by difficulties in financing access (Recalde et al, 2015). Thus, the low level of success is not due to the policies design and instruments but rather to boundaries conditions.

Brazil also had some limitations with the PROINFA, such as, insufficient supply of wind turbines, nationalization requirements, difficulty of financing for small investors, speculative behavior of some actors and difficulties in connecting some projects. As a result the program suffered significant delays. In effect, the total installed capacity of wind generation by 2010 was 7127 MW, when it should have been 14000 MW in 2006 (de Castro et al, 2010). Despite the stress in renewable energy, the project was designed to promote alternative energy sources. In the PROINFA national mineral charcoal was included. Clearly, the goal was to improve energy security by increasing energy supply regardless of the energy source (Verdesio, 2003).

With respect to rural electrification programs, both Argentina and Brazil had weaknesses. In Brazil, the PRODEEM ended as a distribution program of photovoltaic imported kits (Verdesio, 2003). At the same time, there was a

[§] Tariff conversion from dollars to Argentinean pesos.

lack of coordination between this program and the National Rural Electrification Program "Luz no Campo" launched in 1999. The aim of this project, in a horizon of four years, was to achieve the electrification of one million rural properties, benefiting approximately 5 million Brazilians regarding poverty reduction and social inclusion (Gusmão et al, 2002). The result of these public policies was the presence of autonomous photovoltaic generation systems in regions in which later the electricity distribution grid arrived (Verdesio, 2003).

In the Argentinean case, the PERMER was successful in terms of expanding the electricity supply to the isolated rural population. Nevertheless, problems arose, such as projects on a limited scale, lack of adequate user training and lack of consideration of system maintenance (Cadena, 2006).

Biofuel production presents certain barriers. First, the production of this energy source has a high opportunity cost because the raw material from which is generated (soybean, corn, sugar cane, etc.) cover other basic needs, such as food. The promotion of energy crops without proper planning deepens the trade-off mentioned (Achkar and Dominguez, 2008). Consequently, the minimum quantities of raw materials required by the population and the price evolution of these products constitute a barrier to biofuels production. If international commodity prices are high, it is very difficult produce biofuels given the higher costs (Bittencourt and Reig Lorenzi, 2009).

On the other hand, oil price is also an influential factor in biofuels production (Bertoni et al, 2010). Oil price is taken as a reference to determine biofuels price. Thus, it is necessary a high oil price to ensure a considerable return to the projects (Achkar y Domínguez, 2008).

This situation is further aggravated in the case of Uruguay that does not have land to expand the production of the necessary raw materials. The country exhausts the agricultural frontier in the early twentieth century. Therefore, if biofuels production is increased it will lead to a displacement of productive activities of other agricultural sectors (Bittencourt and Reig Lorenzi, 2009).

Thus biofuels have multiple advantages as well as disadvantages. The advantages are its renewability, the reduction of oil imports and GHG, the creation of agriculture employment and the promotion of business and innovation (Poniachik, 2006 in Muñoz et al, 2007). On the other hand, its disadvantages consist in the difficulty of transportation, raw material high incidence in production costs, the impact on the crop price used as input, increased use of fertilizers and soil exhaustion (Poniachik, 2006 in Muñoz et al, 2007).

Summarizing, in all the countries under study it is present, at least theoretically in the legislation, the quota system as an incentive to NRES. Nonetheless, the mechanism to determine the energy price is different in each case. Argentina has a Feed-in Premium system, Brazil has a FIT scheme and Uruguay has a bidding system. Only Brazil and Uruguay have a Net Metering system to promote NRES. Moreover, in every case there are many economic instruments that provide fiscal incentives to generators that use NRES.

In conclusion, all the countries studied have a wide variety of instruments for the promotion of renewable energy. However, Brazil and Uruguay have achieved better results in their energy matrixes compared to Argentina. Part of their success can be explained by the existence of a complementary legislative framework to the main laws and decrees that promote NRES and by the inclusion of national productive development objectives in these

policies. The greatest difficulty in the case of Argentina was the restricted access to financing.

IV. Concluding Remarks

When analyzing comparatively the public policies to promote NRES in the different countries, we can see that in Brazil and Uruguay policies are articulated with other macroeconomic objectives, such as the development of domestic industry, the generation of employment and the growth of the domestic market. Argentina presents a significant number of instruments to promote NRES, nevertheless those instruments have failed to increase the renewable energy share in electricity generation, which at the present is 1% (CAMMESA, 2015).

In Argentina, the policies implemented to promote NRES are punctual and isolated solutions, that is to say there is not a long-term planning. The government should implement projects that promote productive development processes. For this reason is extremely necessary to address the energy sector problems as systemic problems into a multidimensional and coherent project for the energy sector. To this respect, public policies to promote NRES should not only cover energy objectives, but also economic, productive, social, political and cultural objectives, in order to sustainably diversify the energy matrix (Garrido, 2016).

Failures exist because the effectiveness of a promoting instrument depends on the context in which it is applied. Indeed, previously it was remarked that the Feed-in system is very efficient according to international evidence. However, in Argentina it was not successful. On the other hand, the bidding

system is not usually the most recommended instrument but has encouraged a strong share of renewable energy in Uruguay.

In this context, it is evident that what matters is not the instrument used, but the relationship between the design of public policies and the economic, institutional and social framework in which they are applied. In other words the effectiveness of public policies depends on boundaries conditions, that is to say, the political, economic, social and institutional context. These conditions include institutional quality and enforcement mechanisms, the ability to adapt to new technologies, access to financing and technological knowledge and human capital (Recalde et al, 2015).

In the particular case of Argentina, its low performance on renewable energy is due to low level of political will and weak regulatory frameworks and economic and financial aspects (Recalde et al, 2015). An example, which accounts for the weakness of the regulatory framework, is the absence of complementary legislation establishing rules and required agencies to carry out programs and projects involving renewable energy sources.

Nevertheless, we highlight that Argentina has great potential in the field of renewable energy, however there are currently barriers to their development. These barriers must be taken into account by policy makers to achieve better results in the future.

Finally, we believe future researches should tackle a series of questions such as: Which is the role of renewable energy in the energy integration in the Mercosur region? To what extent is profitable to continue promoting renewable energy? How will affect the expansion of renewable energy, through distributed generation, the actual structure of energy markets? Can renewable energy improve energy access?

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