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Renewable energies as tools for rural development

Energías renovables como herramientas para el desarrollo rural

Energias renováveis como ferramentas para o desenvolvimento rural

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Abstract

From the beginning of the 2000s, Uruguay is systematically working on Renewable Energies (RE), with concrete policies for the development of the RE sector, with short, medium, and long-term clear objectives. At this stage, and under different recently passed laws, the development of the sector has been driven through large investments by private and state enterprises, leaving aside the development of small local experiences that pursue the objectives set out by law. Based on a sample of 60 family farmers from the south, this study collected information on the main sources of energy used at households and farms, the energy cost, among other parameters. Also, the study reports farmers' opinions about different aspects related to the concept of renewable energy. Results show that electricity is the main energy source used for households, and fossil fuel for farming. Most respondents believe that the cost of energy linked to the production process is high. A significant percentage considers that RE sources may be an option for rural development. In addition, respondents believe that there should be a State policy that ensures small producers' access to RE, and suggest the implementation of a proposal with this goal.
Keywords: renewable energy, rural development, family farmers

Resumen

Desde el inicio de los años 2000 Uruguay ha comenzado a trabajar en el tema de las energías renovables (ER) en forma sistemática, con políticas concretas para su desarrollo, y objetivos claros a corto, mediano y largo plazo. En esta etapa, y al amparo de distintas leyes aprobadas recientemente, se ha impulsado el desarrollo del sector con obras de gran porte mediante inversiones de empresas privadas y estatales, quedando relegado el desarrollo de experiencias de pequeña escala a nivel local. A partir de una encuesta realizada a una muestra de 60 productores familiares de la zona sur, este estudio recoge información acerca de las principales fuentes de energía destinadas a la vivienda y la producción, y el costo que representa esta energía, entre otros parámetros. También se relevó la opinión de los productores sobre diferentes aspectos inherentes al concepto de energía renovable. Los resultados muestran que en lo que a vivienda se refiere, la energía eléctrica es el principal recurso energético utilizado, y a nivel del proceso productivo, los combustibles fósiles. La mayoría de los encuestados opina que el costo de la energía vinculado al proceso productivo es alto. Un porcentaje importante visualiza que las fuentes de ER pueden ser una opción para el desarrollo rural. Además, considera que debe existir una política de Estado que asegure el acceso de la pequeña producción a las ER, y que se debería implementar una propuesta con este objetivo.
Palabras clave: energías renovables, desarrollo rural, producción familiar

Resumo

Desde o início dos anos 2000, o Uruguai começou a trabalhar a questão das energias renováveis (ER) de forma sistemática, com políticas concretas para o seu desenvolvimento, com objetivos claros a curto, médio e longo prazo. Nesta fase, e sob a protecção de diversas leis recentemente aprovadas, o desenvolvimento do sector tem sido promovido com obras de grande envergadura através de investimentos de empresas privadas e estatais, deixando relegado o desenvolvimento de experiências de pequena escala a nível local. A partir de levantamento realizado em uma amostra de 60 produtores familiares da zona sul, este estudo coleta informações sobre as principais fontes de energia para a habitação e produção e o custo que essa energia representa, entre outros parâmetros. Também foi levantada a opinião dos produtores sobre diversos aspectos inerentes ao conceito de energia renovável. Os resultados mostram que, no que diz respeito à habitação, a energia elétrica é o principal recurso energético utilizado; e ao nível do processo de produção, os combustíveis fósseis. A maioria dos pesquisados acredita que o custo da energia atrelado ao processo produtivo é alto. Uma porcentagem

importante visualiza que as fontes de ER podem ser uma opção para o desenvolvimento rural. Além disso, considera que deve haver uma política de Estado que garanta o acesso da pequena produção à ER, e que uma proposta com esse objetivo seja implementada.

Palavras-chave: energia renovável, desenvolvimento rural, produção familiar

1. Introduction

In Uruguay, the body responsible for defining energy policy is the Ministry of Industry, Energy and Mining (hereinafter MIEM by its Spanish acronym). The objective of energy policy, according to MIEM, is to "satisfy all national energy needs at adequate costs for all social sectors and that provide competitiveness to the country". It also seeks energetic independence within the regional integration framework and the promotion of healthy energy-consumption habits. Concerning policies, it defines that these must be sustainable both economically and environmentally, and considers energy policy as an instrument to develop productive capacities and promote social integration. To achieve this objective, four lines of work that address the following aspects were established: 1) institutional, 2) supply, 3) demand, and 4) social. Based on the strategic guidelines, short (2015), medium (2020), and long-term (2030) goals were set. For 2015 (short term), the aforementioned policy proposed that indigenous renewable sources reached 50% of the total primary energy matrix.

In this context, this study mainly aims to explore the viability of the use of renewable energy as a tool for rural development in typical family production systems in the departments of Canelones and Montevideo. The specific objectives are: 1) to review the current regulatory framework and the energy situation in Uruguay; 2) to investigate the interest of the agricultural producers included in the subject study; 3) to explore the importance of energy, both at productive and household levels, and 4) to know the main sources of energy used by producers and their cost.

Regarding the concept of renewable energy (hereinafter RE), the definition of the National Institute of Agricultural Technology (INTA-Argentina) is considered for this study, which specifies that "RE is the energy that is obtained from virtually inexhaustible natural sources, some due to the immense amount of energy they contain, and others because they are capable of regenerating through natural means"(1). Some examples of renewable energy resources are: hydropower, wind, geothermal, solar, and bioenergy (included biomass and waste of various kinds).

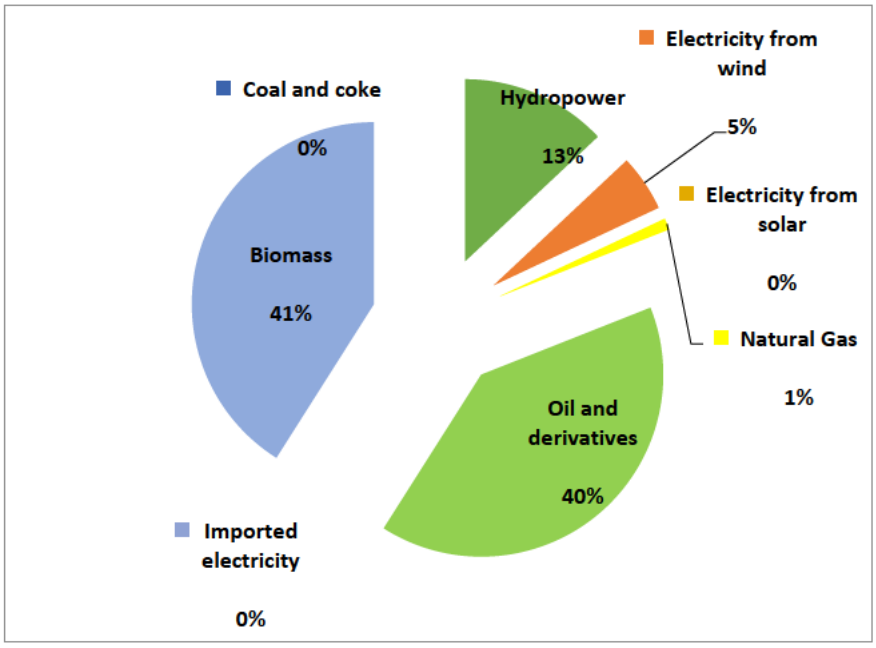
By 2016, the country's energy matrix consisted of the following: 41% biomass, 40% oil and derivatives, 13% electricity of hybrid origin, 5% wind energy, and 1% natural gas (Graph 1).

As can be seen in Graph 1, a high percentage of the energy matrix comes from oil and its derivatives. By 2016, biomass contributed 41%, similar to the proportion of oil, surpassing electricity from hydroelectric origin, which contributed by 13%. The contribution of electricity from wind power reached 5%. As of 2014, the contribution of photovoltaic solar electricity started being represented in the matrix. In 2016, it contributed 0.1% to the energy matrix, while natural gas contributed by 1%. The percentage of imported electricity varies widely every year and is directly linked to the annual water regime, being more important in low rainfall years. According to these data, the short-term goals projected for the sector at national level have been met. Parallel to the use of renewable sources for the generation of electricity, it was expected for the short-term period that the contribution of non-traditional non-renewable sources would reach 15% of electricity generation, distributed in wind energy 1,000 MW (between public and private), and biomass 200 MW (of private origin). By 2015, at least 30% of the country's agro-industrial and urban waste was expected to be used to generate some type of energy(3).

In 2018, the total energy supply increased by 5% compared to 2017. Biomass proportion (firewood, charcoal, biomass residues and biomass for biofuel production) exceeded the use of oil and derivatives for the third consecutive year, which has been,

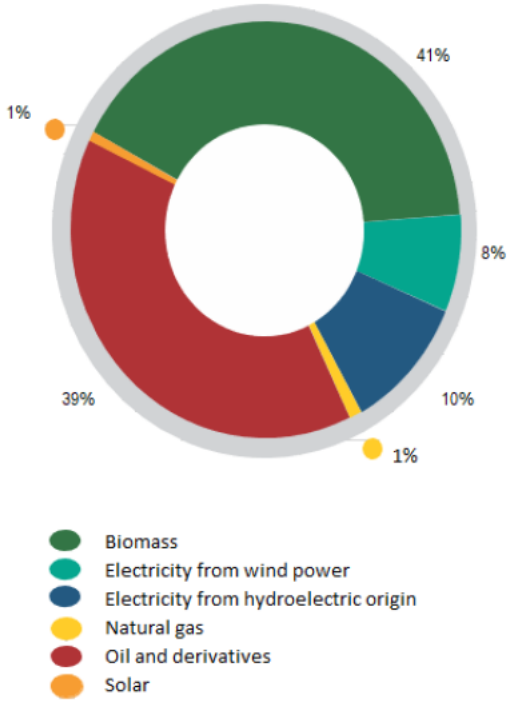
historically, the main supply source of the country. The contribution of solar energy and electricity from wind energy has also increased since 2016, while the contribution of electricity of hydroelectric origin decreased (Figure 2).

Graph 1. Contribution of the various energy sources to the 2016 National Energy Matrix



Source: Compilation based on data from the MIEM[2].

Graph 2. Contribution of the various energy sources in the National Energy Matrix (2018)



Source: National Energy Balance 2018[2]

Biodiesel production from 2009 to 2013 yielded 915,000 barrels of biofuel or about 145.5 million liters of fuel, equivalent to 10% of Uruguay's annual consumption. By 2013 there was an installed capacity of 1,100,000 barrels/year[5]. The objectives also projected the universalization of access to the country's electrification by 2015, as well as expecting that by that year the culture of energy efficiency would have permeated on the society, and national companies would be able to produce energy inputs and develop energy-efficient processes. In recent years, the pace of electrification has been accentuated in the most remote parts of the countryside, a task UTE has steadily undertaken. The agreement that gave rise to the Rural Electrification Program was signed in 2012, integrated by OPP, MIEM, MGAP, MIDES_TM, MVOTMA, MEVIR, INC and ANTEL in addition to UTE, in order to promote and facilitate electricity access to villagers in areas far from urban centers. Between 2010 and 2014, 5,000 km of electricity grid were installed for 5,000 families, while between 2015 and 2019 it was 4,100 kilometers for 3,000 families. Also, 170 public schools have been connected to

electricity throughout the period. Uruguay currently has an electrification rate of 99.8%[6][7].

Regarding solar thermal energy, instruments were expected to allow the introduction of this energy in the residential, industrial, commercial and service sectors. In the same direction, the introduction of small hydroelectric plants[8] was expected. In line with the targets set for the development of this sector, a regulatory framework was generated that accompanies and allows the development of the energy sector linked to the RE. Hard work has been directed to promote investment[9] aimed at diversifying the power matrix and decreasing oil dependency, looking to encourage the participation of indigenous energy sources, in general, and non-traditional renewable, in particular[10]. In this context, the approval of the regulatory framework of the electric system, the incentives for the RE sector with Decree 354/009 and Law 18585 on the Promotion of Solar Thermal Energy should be mentioned, among another series of decrees that implemented the policy for the development of non-conventional renewable sources on a medium and large scale[11]. Regarding the agricultural sector, no specific lines of work have been defined that benefit the users of the various energy sources.

All the aforementioned benefits and promotions have resulted in an important response from the investment sector, with a greater contribution to the electricity grid by energy produced by biomass, first, and wind generation, later. It is no coincidence that in most biomass utilization projects, the direct participants (or partners) interested in transforming a problem into an economically viable opportunity are the generators of these "wastes". The presentation of these projects has taken the international agreements that Uruguay has ratified as a framework, such as the Kyoto Protocol. Firms such as UPM, Weyerhaeuser and ALUR, which appear as investors, are also members of the Uruguayan Association of Private Generators of Electric Power (AUGPEE). The institutional objectives of this Association are to contribute to the country's energy diversification, provide solutions that mitigate the national energy crisis and dependence on imported fuels, with environmentally friendly solutions, generating investment and employment opportunities in the national territory, and promoting the participation of the national industry in generation technologies.

Table 1 shows the main companies (by authorized power) that have invested in energy production based on RE in the country.

As shown in Table 1, there is a large number of energy-generating enterprises, which shows the dynamism of the sector and the expansion it has had in the various departments of the country. According to data provided by MIEM[12], there are 37 companies generating energy through wind farms; in total, these generate 1,330 MW. Five companies generate photovoltaic energy, contributing 89.6 MW; whereas nine are dedicated to biomass transformation, which produce 174.7 MW. Only two companies produce biogas, for a total of 1.6 MW. Among the largest recent investments in MW production, there are also some state-owned, such as the Pampa wind farm, or the photovoltaic solar power plant, owned by the National Energy Directorate, located in Salto. It is connected to the National Electric Power Grid and was made possible thanks to funding by the Japanese Government in the cooperation framework between the two countries[13]. The department of Canelones has the “Solís de Mataojo” wind farm, and a wind turbine located in Las Piedras. The latter is the only one installed in the area included in this study. Although there is a considerable portion of national companies working on the issue, there are also some foreign companies, or partnerships between national and foreign companies[12].

Although these large enterprises are installed in rural areas, they have nothing to do with the rural development approach proposed in this study. In line with Vilches and others[14], the training and well-being of people living in rural areas must be addressed for equal rural development, aiming at the eradication of extreme poverty and avoiding the migration to marginal areas of cities. In addition, sustainable agricultural production must be achieved to ensure that all human beings have access to the food they need. At the same time, it is necessary to protect and conserve the capacity of the natural resource base, so that they continue to provide production, environmental and cultural services.

Table 1. Main companies that are currently contributing to the electricity grid by renewable sources and authorized power

Name of the plant	Source	Department	Authorized power	Company
Pampa Wind Farm	Wind	Tacuarembó	141.6	Pampa financial trust (UTE and investors)
Valentines Wind Farm	Wind	Florida/Treinta y Tres	70	Areaflin SA (UTE and investors)
Santa Rita Wind Farm (Palomas)	Wind	Salto	70	Invenergy Wind
UTE Juan Pablo Terra	Wind	Artigas	67.2	UTE
ROUAR-Artilleros	Wind	Colonia	65.1	UTE- Electrobras
Peralta I (Aguas Leguas SA)	Wind	Tacuarembó	58.8	Aguas Leguas SA
Peralta II (Aguas Leguas SA)	Wind	Tacuarembó	58.8	Aguas Leguas SA
La Jacinta	Solar	Salto	50	Solar Farm SRL
Alto Cielo SA	Solar	Artigas	20	Terraform Global Inc.
Microgeneration connected to the grid	Solar		9.3	various
Raditon	Solar	Paysandú	8	Sky Solar Holdings Ltd.
Montes de Plata	Biomass	Colonia	80	Montes del Plata (Arauco and Stora Enso)
UPM	Biomass	RioNegro	40	UPM-Kymmene Corporation
Galofer	Biomass	Treinta y Tres	12.5	Galofer ANCAP-PDVSA
Bioener	Biomass	Rivera	11.5	Bioener (Cofusa and Urufor)
Fenirol	Biomass	Tacuarembó	8.8	Fenirol (consortium of 4 economic groups)
I de Maldonado-Aborgama	Biogas	Maldonado	1	Municipality of Maldonado-Aborgama-Ducelit SA
Lanas Trinidad	Biogas	Flores	0.6	Lanas Trinidad SA

Source: MIEM[12]

Although the RE issue has developed more strongly in the last decade, there is previous national experience related to rural development. One of the experiences that occurred in the 1980s was the production of biogas on farms linked to the dairy industry, an experience promoted by CONAPROLE (National Cooperative of Dairy Producers) within the framework of the extension service that the cooperative had. This project led to a total of 30 biodigesters in dairy farms, and others that were carried out at the request of other institutions, such as the Municipality of Río Negro (pers. commun. interview with qualified informant). Another example is the production of biofuels (ethanol and biodiesel) and biomass for the generation of electricity by ALUR since 2006, within the framework of the Frente Amplio Government, an activity with great impact on a social and economic level. In the case of ALUR, the development of the agro-energy industry located in Bella Unión has made agricultural production in this area viable, particularly of sugarcane and sorghum crops, as well as other crops such as soybeans, canola and sunflower[15]. This has been made possible by financial tools (Agricultural Fund, guarantee

trust), technical assistance, services and training through the Agroenergy Technologist degree dictated by UTU. According to ALUR[16], the plant consumes 450,000 tons of sugarcane per year, and in total about 300 producers are linked to this industry.

The solar plan has been marketed from the beginning of this decade by UTE (State Power Plants and Electric Transmissions) in coordination with the National Energy Directorate (DNE), Mortgage Bank of Uruguay (BHU) and the Energy and Water Services Regulatory Unit (URSEA). Such plan promotes the use of solar thermal energy at household level, oriented to water heating and electricity savings through the installation of solar water heaters[17]. Energy efficiency has been another line of work of this public company. Most of the funding for research related to the subject of RE corresponds to the National Agency for Research and Innovation (ANII), and the Engineering School of the University of the Republic.

2. Materials and methods

Since no previous work was available at the time of the study on the use of RE by the population of family producers, this study was exploratory. Thus, to gather the information, a sample of producers was used, built on the basis of three criteria: 1) farmers that developed their productive activity in the south of the country, more accurately in the departments of Canelones (west area) and Montevideo; (2) that were family producers, and (3) that the sample reflected the diversity of production systems in those departments.

To collect the information, producers linked to rural organizations, MGAP projects, and participants of the Rural Development Panels (MDR) of the departments of Montevideo and west Canelones were surveyed. There was not a comprehensive list before the information collection. While performing MGAP work-related tasks, the sample was completed as contact was made with producers with the established characteristics, either on farm visits, producer organizations or in the MDR, generally carried out at the headquarters of farmers' organizations located in various locations of the defined departments.

In order to collect information quickly, neatly and cheaply, a self-managed survey format was chosen. Before applying the survey, a validation was carried out that consisted of applying the survey model to producers who did not participate in the sample, to correct the various problems that may arise after completion. Fieldwork took place between November and December, 2013.

The survey was conducted on a total of 60 producers, who answered the questions in writing, in the presence of the thesis researcher. Qualitative and quantitative questions were included. Qualitative questions, for the most part, sought to know the opinion and the degree of knowledge on the subject, whereas quantitative ones assessed energy issues compared to, for example, production costs.

3. Results and discussion

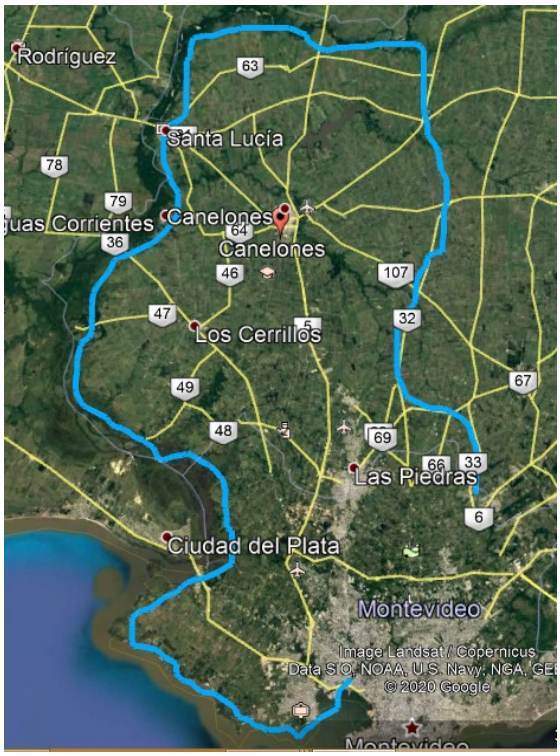
Of the total surveyed producers, 87% were located in the department of Canelones, and 13% in rural Montevideo (see Figure 1).

Farms were categorized into four groups according to their main products. Group 1 was the largest (55%) and comprised of the farms engaged in horticulture, fruit farming and grape production as main products. As these are considered intensive productions, the data analysis of these production units was carried out together. Group 2 consisted of dairy farmers, who accounted for 15% of all interviewees.

Group 3, made up of 5% of the producers, was engaged in forage production as main product. Finally, Group 4 consisted of productive units that had as main products: livestock (sheep, pigs, cattle), cereal and other crops rabbits or nurseries, among others; this last group, called "others," accounted for 25% of interviewees. The percentages of each group were not predefined but arose from the sample itself.

Regarding the age of the sampled farmers, more than the half were between 41 and 60 years old, with the minimum age being 20. On average, producers had been linked to agricultural activity for 29 years.

Figure 1. Area map of fieldwork



Source: own elaboration based on Google Earth ProR

If we look at the energy demands of the producers' homes, mainly three energy sources appeared as the most widely used: electricity, gas and firewood, in that order. In 91% of the cases, the main source of house energy is electricity, although very few cases used electricity as the only source of energy. Most interviewees place electricity costs between 61 and 80% of the total household energy costs. Gas appears as the second source of energy, in 57% of the cases, not exceeding 20% of total energy costs. The third source of energy chosen by the surveyed is firewood. In this case, the cost is lower than 20% of the total household energy costs. Firewood is directly related to household heating, which is seasonal. However, with this marked seasonality, it becomes the third source of energy, in 60% of those who have three sources of energy in the house. A very low percentage of fossil fuels is linked to household energy costs.

In terms of production, 67% of interviewees have fossil fuel as their main source of energy, with most of the farms being the only source of energy. The remaining percentage (33%) uses electricity as its main source. These two energy sources were identified as of greater importance for production. Fuel is between 61 and 100% of the total energy-related costs required for production.

Electricity appears in 62% of respondents as the second source of energy, which in most cases is less than 20% of production-related costs. In the areas where irrigation is incorporated, the use of electricity is very high, but temporary, being diluted among the permanent energy costs, such as fuel. Electricity cost is stable throughout the year in dairy production. Only four cases presented a third source of energy, which was firewood in 50% of them.

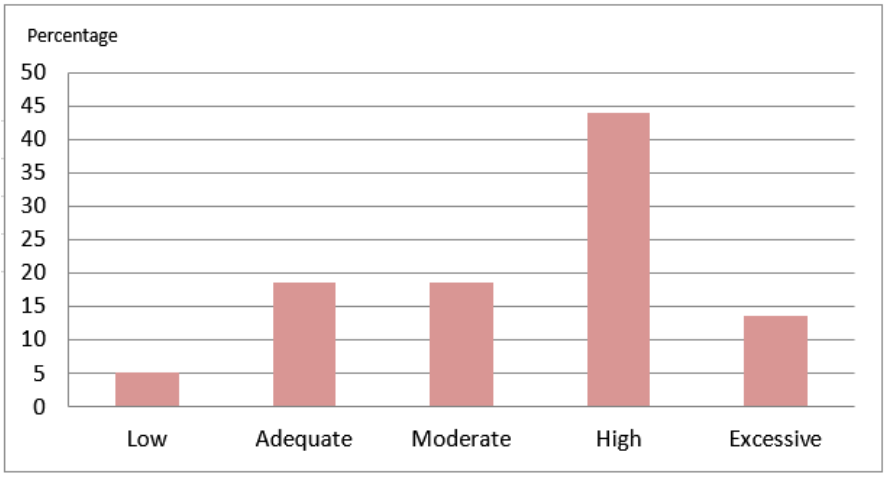
When Interviewees were asked about their opinion on the cost of energy needed to carry out the production process, most considered the cost to be high. The answers obtained were based on a closed question with 5 categories, which can be seen in Graph 3.

As shown in Figure 3, around 45% of interviewees believe that the cost of energy for the production process is high, although there are opinions in all categories, including both ends of the scale. This is certainly very closely linked to the type of production and the type of farm. Some of this is explained by the analysis of the answers grouped by item.

When consulted on the percentage of energy cost linked to production compared to total production costs, as well as the estimate of the monthly energy cost, the answers are quite different depending on the item in question, which led to work with production grouping, as explained above.

Table 2 shows the values of the average total energy cost according to the established groups. To describe the inequalities in the answers, it also shows the maximum and minimum amounts found in this answer.

Graph 3. Percentage of interviewees according to opinion of energy cost linked to total production costs



Source: Authors' own creation

Table 2. Average annual energy cost and percentage according to type of production related to the total cost of production

Group	Average monthly expenses		Total cost of production %	% of interviewees
	Minimum	Maximum		
Horticulture, fruit farming and grape production	1500	4000	0-25%	50%
Dairy farmers	8000	180000	0-25%	88%
Forage production	1000	1600	26-50%	75%
Other productions	1800	6000	26-75%	67%

Source: Authors' own creation

Table 2 shows the maximums and minimums found in the answers regarding the estimate of the energy cost in the total production cost. In this case, working with averages was rejected because of the differences in the answers. For these reasons, the extremes are presented here. These differences are basically due to the type of item and technology applied in each farm, as well as the level of intensification (associated with input dependence, including energy) and the farm area. The aforementioned are only hypotheses that may explain these differences. For example, in the group of intensive productions (Group 1), some producers pay 1500 Uruguayan pesos a month on average for energy-related expenses (diesel, electricity, etc.), and there are others who on average pay about 40,000 Uruguayan pesos a month.

The last two columns of the table show the percentage that the cost of energy represents in the total costs associated with production. For example, in Group 1, the cost of energy represents less than 25% of the total production costs for 50% of interviewees. Group 2 (dairy) presents the same percentage for 88% of interviewees, although monthly energy costs are much higher than those of Group 1. For Group 3 (forage production) and Group 4 (other productions), although the monthly

cost of energy to produce is lower, it represents a higher proportion of total production costs. Therefore, it can be anticipated that a benefit in energy cost reduction could have a greater impact on these last two groups than on the first two.

Although on several occasions we mentioned that the use of RE is not new, when the producers were consulted about present sources of RE linked to the production of their farms, 56% of interviewees did not remember or did not answer this question. Those who answered affirmatively mentioned windmills, animal traction, firewood, batteries, biogas, among others, as applied technologies. Windmills are the most mentioned technology.

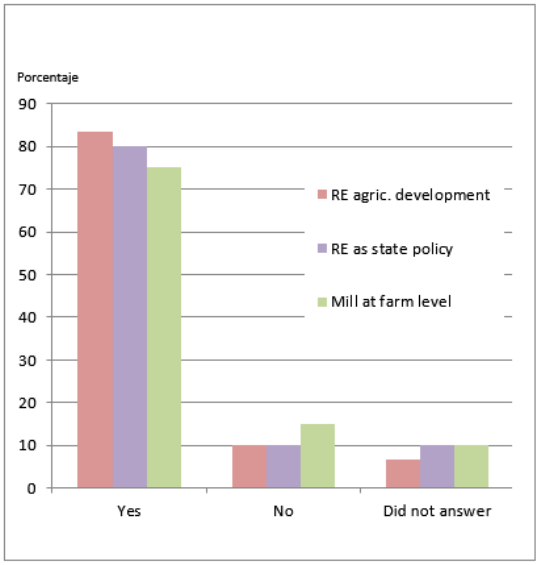
When interviewees were asked about the first thing they thought of when the term *renewable energy* was mentioned, the answers were varied, although words related to wind and sun resources predominated over others. The association of this word with the reduction in pollution, the environment, and natural resources also appears with strength. It is strongly linked to the issue of cost reduction (see Figure 2).

Figure 2. Most common associations generated by the RE concept expressed in frequency of answers

Source: Authors' own creation

The last questions focused on gathering the farmers' opinions regarding whether they agreed that REs are an option for agricultural development, and if they considered that the use of RE in the agricultural sector should be a national state policy. Finally, producers were asked if they would accept installing a windmill on their properties. As can be seen in Graph 4, 80% answered affirmatively to the question on RE as an option for agricultural development, while 75% answered affirmatively on the other two questions. They justified their answers on issues such as cost reduction, efficiency, sustainability, environment and reduction of dependence on other types of energy. When asked if the RE should be a public policy for the agrarian sector, nearly 80% of interviewees answered affirmatively. Additionally, some suggestions concerning the type of support that the State should provide referred to issues such as financing, planning, continuity, guarantee in the energy supply, cost reduction, breaking the oil monopoly, the possibility of having economic resources for their development and accessibility. Farmers viewed State investment in RE as a saving for the country. The negative points were linked to the obligation and the implementation of taxes linked to the activity. The need to take into account the costs and scale where this type of technology can be applied was also raised.

Graph 4. Percentage of interviewees according to answer based on opinion on RE as a tool for rural development, as state policy, and opinion on the installation of a windmill at farm level



Source: Authors' own creation

Considering whether they would accept the installation of a windmill on their premises, 75% agreed, as it involves savings, cost reduction, and returns on

the income paid by the investor owner of the mill, among others. Those who disagreed expressed that the limitation was the size of the farm. Only one interviewee mentioned noise pollution as a problem.

4. Final considerations

From the results obtained, a strong dependence on two energy sources is detected, both in farms and rural households. While the main energy resources used for production are fossil fuels and electricity, in the household the main source of energy is electricity. This low diversity in energy sources represents a source of vulnerability for producers, even more so if we consider that fuels are regulated by international price-setting markets. Regarding electricity use, although the country has increased its energy production from renewable sources to the point of being an energy exporter to neighboring countries, and while the actual cost of energy has dropped[6], farmers have not noticed this and increasingly demand this energy resource. Moreover, the producers included in this study were interested in this topic, showing knowledge and some accumulated experience regarding technologies used in the past and the present. The clearest perception is that the development of RE can help to lower costs (defined as high), to take care of the environment and natural resources. Adequate technology for small scale is not clearly identified by interviewees who mentioned as drawbacks the farm sizes and the costs associated with the application of technology, which is perceived as complex and expensive for the small farms, and cheaper for the large ones. Interviewees believe it is possible to overcome these problems with a policy for the sector that includes RE not as a salvation for rural producers, but within a set of measures. This policy would ensure planning, financing, and sustainability of the project, although taxes and obligations related to the development of the RE sector are a concern.

This study, which evidently is only an approach to the RE issue, suggests that it is vitally important that people associated with the sector participate in the development of any policy for the agricultural sector, to identify their needs and possibilities. In this process, it is also necessary to research the subject, to generate knowledge adapted to the country and the needs of family producers. Farmers' products, management and technology types, among other aspects, must be studied in-depth to analyze what the best development possibilities are and the impact the proposals generate from a social, environmental and also economic point of view. In vulnerable sectors, the investment cost of RE is high, and repayment can generally take several years, so it requires thinking about possible financing methods. To avoid these proposals from becoming a problem within the production system, plans or projects must contemplate, apart from each farm's characteristics and area, the projection of the farm and products for at least 20 years.

According to Vassallo[18], when a process of economic growth and social participation is promoted, it has to be thought as structured in a planning framework that orients its development, so that it is not freed to the power of each social group. Flexible, indicative and decentralized planning that is open to the participation of the sectors involved is proposed to successfully carry this out.

Although the State has promoted policies related to the development of the RE sector, and the goals set for the short term were fulfilled, they were oriented to the development of large public, public-private and private enterprises located in the countryside all over the country. However, considering the definition of rural development proposed in this study, these policies do not represent an example of rural development of the influence area. The regulations defined for small-scale (micro-generation) production have not been effective for this sector, because there are currently no effective tools in place to apply these policies. Although there is a framework from which to build on, there is a long way to work with those who produce on a small scale, both in terms of REs adapted to their needs, and other aspects that contribute to their sustainability.

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Author contribution statement

This article was based on the Master's Thesis in Agricultural Sciences, Social Sciences option, by the Agronomist Mag. Patricia Primo, completed in 2019. The orientation and correction of the study were in charge of Dr. Marta Chiappe (PhD). The article was developed by Primo. The article correction, bibliography update, and revisions from the evaluations were mainly in charge of Chiappe, as well as the adaptation of the bibliography to the Vancouver standards.

References

1. Energías Renovables para el Desarrollo Rural. Buenos Aires: INTA; 2011. 198p.

2. Ministerio de Industria Energía y Minería, Dirección Nacional de Energía (UY). Balance Energético Nacional 2018 [Internet]. Montevideo: MIEM; 2018 [cited 2020 Set 16]. 8p. Available from: https://bit.ly/3kojmwl.

3. Ministerio de Industria Energía y Minería, Dirección Nacional de Energía (UY). Política Energética 2005-2030 [Internet]. Montevideo: MIEM; [date unknown; cited 2020 Set 16]. 14p. Available from: https://bit.ly/3c6dQve.

4. República Oriental del Uruguay, Poder Legislativo. Agrocombustibles. Ley N° 18.195 [Internet]. 2007 [cited 2020 Set 16]. Available from: https://bit.ly/3koktw1.

5. ALUR. 1.000.000 de barriles de combustibles: lecciones aprendidas y futuro del bioetanol y el biodiesel en Uruguay [Internet]. 2013 [cited 2020 Set 16]. Available from: https://bit.ly/3hBg9la. Requires license to access.

6. UTE: de gestionar los apagones a la revolución energética. La República [Internet]. 2019 Sep 28 [cited 2020 Set 16]. Available from: https://bit.ly/2RtjSwN.

7. Casi 300 familias rurales accedieron a la electricidad en 2019. UTE [Internet]. 2020 Jan 21 [cited 2020 Set 16]. Available from: https://bit.ly/3hxzQk5.

8. Uruguay XXI. Informe de energías renovables [Internet]. 2013 Apr 19 [cited 2020 Set 16]. Available from: https://bit.ly/2RD3E3X.

9. República Oriental del Uruguay, Poder Legislativo. Interés nacional, promoción y protección. Ley N° 16.906 [Internet]. 1998 [cited 2020 Set 16]. Available from: https://bit.ly/3hAmcfS.

10. UTE. Reporte Ambiental 2009 [Internet]. Montevideo: UTE; 2010 [cited 2020 Set 16]. 25p. Available from: https://bit.ly/3hEvyXY.

11. Uruguay XXI. Oportunidades de inversión: energías renovables [Internet]. Montevideo: [publisher unknown]; 2020 [cited 2020 Set 16]. 44p. Available from: https://bit.ly/2E6laux.

12. Ministerio de Industria Energía y Minería, Dirección Nacional de Energía (UY). Mápas Energéticos [Internet]. Montevideo: MIEM; 2017 [cited 2020 Set 16]. 78p. Available from: https://bit.ly/3koj20u.

13. Bentancur D, Scarone M, Mula M, Sierra W. Desarrollo de plantas fotovoltaicas de gran porte conectadas al Sistema Eléctrico Nacional en Uruguay [Internet]. Montevideo: CIER; 2013 [cited 2020 Set 16]. 8p. Available from: https://bit.ly/3iwCkAm.

14. Vilches A, Gil D, Toscano JC, Macías O. Desarrollo rural y Sostenibilidad. OEI [Internet]. 2014 [cited 2020 Set 16]. Available from: https://bit.ly/33wlpI1.

15. Córdoba D, Chiappe M, Abrams J, Selfa T. Fuelling Social Inclusion? Neo-extractivism, State-Society Relations and Biofuel Policies in Latin America's Southern Cone. Dev Change [Internet]. 2017 [cited 2020 Sep 16];49(1):63-88. Available from: https://bit.ly/3iwpsu5.

16. ALUR. Complejo Agroenergético-Bella Unión, Artigas [Internet]. [date unknown; cited 2020 Set 16]. Available from: https://bit.ly/33wmTlz.

17. Uruguay Presidencia. Plan Solar promoverá instalación en 2012 de colectores solares en sector residencial [Internet]. 2012 Jan 11 [cited 2020 Set 16]. Available from: https://bit.ly/33zNJJp.

18. Vassallo M. Reforma Agraria: una estrategia de Desarrollo Rural. Montevideo: Ediciones de la Banda Oriental; 1987. 173p.