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Received: 07-February-2017; Accepted: 18-August-2017; Published: 18-September-2017

Abstract: The present work focuses on the analysis of the Paraguayan energy sector starting from the first Energy Balance in Useful Energy of Paraguay, elaborated through a joint project between Itaipu Binacional and the Itaipu Technological Park Foundation - Paraguay, with the collaboration of the Bariloche Foundation - Argentina, taking as base year 2011. The analysis examines the situation of the Paraguayan energy sector in hydroelectric energy, as well as the other components of the Energy Mix. Through the study of the different sectors of energy consumption, these being Residential, Industrial, Transportation, Agriculture and Forestry, and Commercial, Services and Public. The paper also summarizes the energy efficiency initiatives that have been implemented in some sectors, as well as other measures that are expected to be implemented to encourage the rational use of energy in all its sources. Finally, as a complement, the main results of the update to the year 2013 of the Energy Balance in Useful Energy used for the elaboration of National Energy Prospective, basis for the formulation of the Energy Policy Paraguay 2040.

Keywords: Energy Balance, Net Energy, Useful Energy, Performance, Republic of Paraguay.
1. Introduction

Paraguay is located in the center of South America, bordering with Bolivia, Argentina, and Brazil. By 2013, the population was approximately 6,700,000, with a population growth rate (compared to 2012) of 1.62% per year. The country has a Gross Domestic Product (GDP) per capita of USD 4,368; being the lowest of the Southern Common Market (MERCOSUR) and one of the lowest in the region [1].

Despite these indicators, Paraguay has sufficient natural resources to self-supply with energy, especially when considering the use of its water resources. In fact, only in the 200 km stretch between Salto del Guairá and the mouth of the Yguazú River, there is a potential of more than 12,000 MW that is in the process of being fully utilized by the countries bordering the Paraná River. At the same time, in the 600 km stretch of this last point until its confluence with the Paraguay River, a potential of approximately 7,500 MW is estimated, and in fact, partial use of this potential is foreseen in the medium term. With half of the energy coming from the shared tranche with Brazil and Argentina, Paraguay is among the countries with the highest kW index available per inhabitant in the world, but with a minimal internal use of that energy [2], thus wasting the opportunity for this vital resource for the country’s development.

The internal tributaries of the Paraná River are also a useful condition. Among the rivers with the highest hydraulic potential are the rivers Monday, Capiibary, Nacunday, and Charapa, and others already used, such as Acaray and Yguazú. Its total potential is estimated at about 1,500 MW [3].

This high availability of renewable energy, compatible with a model of sustainable development, should be the cornerstone of Paraguay's energy policy. However, within the Paraguayan Energy Mix there is still a clear imbalance, with a high share of biomass, energy sources based on imported oil and a limited penetration of electricity (see Figure 1); that is, Paraguay needs to intelligently take advantage of the available levels of clean electric energy, thus encouraging the penetration of hydroelectric energy into the Mix of energy demand throughout the national territory, while aiming at reducing the use of biomass and Dependence on imported oil [4].

![Figure 1. Final consumption by sources - Paraguay.](image)

With reference to the demand of biomass, the main consumer is the Industrial Sector with its use for the generation of steam. The second sector with the highest biomass consumption index is the Residential Sector, which uses it mainly for the cooking of food [5].
Due to the high values of biomass consumption, there was a need to intensify forest plantations for energy purposes, which is closely linked to the problem of heavy deforestation.

In the hydrocarbons sector, there are oil exploration studies in the western region of the country, which will be able to demonstrate Paraguay's petroleum potential, although still with no commercial exploitation results to date. Regarding the commercialization of fuels, a law was recently promulgated that gives the state company Petróleos del Paraguay (PETROPAR), the power to handle 50% of the oil derivatives market, which implies a great support to the state oil company. In turn, still considering the consumption of petroleum derivatives, it stands out in [5], that the Transport Sector is conformed by a vehicle park quite old, with vehicles that have an average of 15 to 20 years of age, reason why it results is easy to infer that fuel consumption by this sector is inefficient. To alleviate this inconvenience, the Paraguayan State promoted an incentive to upgrade the automotive fleet of the passenger transportation system, through a subsidy (Decree No. 2130/2014). It should also be noted that the use of alternative fuels of national origin has stagnated, as the use of biodiesel and ethanol in local land transport is practically nil.

From the study of the National Balance in Useful Energy for the Republic of Paraguay [5], it is remarked that the total net consumption of Paraguay was 4,324.61 kTep, for 2011. The main source in net consumption was firewood with 27.3% participation; then the diesel is located with 25.2%; and electricity with 15.3%, respectively. In other words, these three sources account for 68% of total net consumption. The remaining sources contribute much smaller shares and in some cases, participation is completely marginal.

With regard to useful energy, electricity is the main source used, with 29.4% of total useful consumption (1,670.71 kTep). Then, the fuelwood follows, with a share of 26.4%. Third is diesel, with a 15.7% share. This significant change in diesel share in relation to net energy consumption is due to its low average performance compared to electricity: 24.1% versus 74.3%, respectively. The low yields of the diesel are due to its main consumption is in the transport, in tractors and mobile machinery of the agricultural and forestry sector.

Vegetable waste has increased its share of useful energy consumption, remaining at 15.2% of total useful consumption. This is due to its average yield of 49.2%, higher than the total utilization average that reaches only 38.6%, as shown in Figure 2.

![Figure 2. Usable energy consumption by sources 2011 - Paraguay.](image)

Last but not least, considering the energy efficiency measures, it is worth noting that in Paraguay historically it has assumed a minor role, taking into account the abundant existence of hydropower resources and that the main concern has always been to extend the service Electricity to the whole
national territory. However, some measures can be found that were applied, for example, in the 80’s, when the change of winter/summer time zone was applied, for the better use of natural light, or in the late 90’s, when differential rates have been charged in peak load times, which seeks to flatten the tip load and, consequently, reduce the technical losses due to the overload of the electrical system, optimizing the use of electric energy. Another measure also applied since the end of the 90’s is the obligation to correct the power factor from medium voltage supplies, which is done from 1998 with the project Rational Use of Energy (ERU), which was widely applied and consisted in the elaboration of a program of measures feasible to be adopted in a way to use the electrical energy in a rational way.

Likewise, the Ministry of Agriculture and Livestock (MAG), promoted the construction of efficient kitchens for food cooking (responsible for 30% of biomass consumption, mostly produced in non-renewable form).

In addition, in another initiative, the mixture of alcohol in the gasoline was propitiated, thus improving the performance of the engines. This initiative emerged in the 80’s and was resumed in the 90’s. The current blend is up to 25%. As a further measure, biodiesel blending was encouraged in diesel fuel, which also improves fuel characteristics. Although the minimum mix of 1% was not reached, during the years 1996-1997 the project Energy Efficiency in the public transport of the metropolitan area of Asunción was developed.

The present analysis is organized as follows: Section 2 presents the methodology used, while in Section 3 the results of the diagnosis of relevant sectors of the energy sector in Paraguay are socialized and the main results of the update are presented of the Energy Balance in Useful Energy 2013. Finally, the conclusions are presented in Section 4.

2. Materials and Methods

The main information provided by the National Balance in Useful Energy (BNEU) is the energy consumption by uses; what sources are consumed by each type of use; as well as these disaggregated consumptions for each homogeneous consumer module. A homogeneous energy consumption module is a group of consumers that belong to the same region, sector, subsector and stratum of income level or size of establishments.

Energy consumptions are measured in net or final energy as well as in useful energy. Useful energy is the net energy at which the losses that occur in consumer appliances and equipment have been deducted. The aforementioned information is not statistically recorded, in what is usually called the administrative information, which has a systematic nature of collection on a regular basis and subject to criteria of consistency. The data are obtained by conducting surveys and by a procedure of statistical inference the information of the universe or sub-universe of consumers is obtained from the information obtained from a representative sample.

Obtaining a higher level of confidence and less error in inference implies a larger size of the samples to be surveyed.

When these parameters are to be obtained for the information with a greater level of detail, for example, the consumption of a certain energy source in a certain use and for a certain homogeneous module, the sample size grows significantly. Another limitation is the availability of information from the universe to calculate the sample size. Then, a compromise solution is adopted between the usefulness of the information to be obtained and the costs of conducting the surveys necessary to achieve the desired level of confidence.

In the case of Paraguay; 6,596 surveys were carried out in total, covering the different consumer sectors at the national level. The detail of the number of surveys conducted in each sector is presented in Table 1.
Table 1. Number of surveys conducted by sector.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Number of surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential - Urban</td>
<td>1.798</td>
</tr>
<tr>
<td>Residential - Rural</td>
<td>1.106</td>
</tr>
<tr>
<td>Commercial and Services</td>
<td>1.463</td>
</tr>
<tr>
<td>Industry</td>
<td>1.157</td>
</tr>
<tr>
<td>Farming and Forestry</td>
<td>958</td>
</tr>
<tr>
<td>Mining and Construction</td>
<td>114</td>
</tr>
<tr>
<td>Total</td>
<td>6.596</td>
</tr>
</tbody>
</table>

In the BNEU of Paraguay, as is customary, the parameters of confidence and error were established at the subsectors level: urban or rural for the residential, and by type or branch of activity or product for the manufacturing industry, commerce and services, and agricultural holdings. The variables used to calculate the sample size are the most representative of the total energy consumption available in each sector: income level for households; personnel employed in industry, commerce and services; and, area cultivated in agriculture. This means that the confidence and error levels apply to the total energy consumption of the defined universes or domains. For another type of disaggregation of the information obtained from the inference errors could be logically greater.

In general, it is expected that the results for those sources and technologies more widespread in the universe under study have a smaller error; on the contrary, when the diffusion of the source or technology is low, the errors on its inferred variables will increase. In addition, the results can be obtained with a much greater detail than the one used for the sample design, and these will have a greater error, for example: energy consumption by region, sub-sector and size of the establishment; energy consumption of a given equipment per subsector and size of the establishment, among other variables.

On the other hand, statistics on total and, in some cases, sectoral consumption are normally available for commercial energy sources. This information obtained for the universe of consumers, usually has a high degree of reliability and is used for the elaboration of National Energy Balances (BEN). Therefore, the results of the net consumption of these sources obtained from the inference are adjusted to the values recorded and presented in the BEN, consequently adjusting the consumption by subsectors, strata, uses and equipment, both in net energy and in useful energy. For non-commercial sources, for which there are no sales or consumption statistics, the results of the inference are kept directly.

For the elaboration of the BNEU, it is necessary to analyze the energy consumption of a sector which means, firstly, to better evaluate the level of satisfaction of the socioeconomic needs represented by the uses of energy and, second, to allow a better comparison between the different energy sources applied to a use since they usually have very different utilization yields.

The analysis of the consumption in net energy is more important for the supply system that must supply the energy sources in quantity, quality and in the opportune moment, to the different consumers, independently of the use of the energy. On the other hand, when considering the level of consumers or demand, it is mainly interested in the analysis of useful energy, since these are the quantities that are effectively used to satisfy human needs and this also allows us to evaluate the competition of the different combinations of source and technology to obtain the same benefit.

The development of the BNEU covers only the final energy consumption in the different sectors and does not advance on the components of the supply. However, the modification of the final energy consumption values, particularly with regard to non-commercial sources, leads to the need to modify the corresponding supply values to maintain the coherence and closure of the balance of each source and at a general level (total).
3. Results

3.1. Results of the energy diagnosis of the relevant sectors

3.1.1 Transport Sector

According to the National Balance of Useful Energy (BNEU) of 2011, the transportation sector is the main net energy consumer sector in the country. For that year, its net consumption was 1,347 kTep, representing 31% of the final energy consumption (Figure 3). The significant growth observed in the motorization rate in Paraguay between 2007 and 2011 gives a concrete signal regarding the need to strengthen vehicle registration databases, since it will continue to be a highly relevant sector in terms of energy consumption, today based on oil derivatives.

From the same study, it is emphasized that the average age of the car park is 15 years for private cars; 14.7 years for vans (and 4x4); 20.7 years for buses; 21 years for trucks; and 7.7 years in the case of motorcycles. In this sense, it is important to emphasize that it is urgent to implement measures aimed at modernizing the cargo and passenger transport fleet, since the consumption of these two older means represents 26% of the consumption of this sector (trucks with 16% and buses with 10%) and, therefore, an improvement in their yields would result in consumption savings and imports of petroleum products.

At the same time, it should be noted that the means of locomotion with the largest share of total consumption corresponds to private cars, with 30%, followed by the consumption of trucks with 16%, vans of commercial use with 15 % and 4x4 vans with 13%. On the other hand, the fuel that has the highest weight on total consumption is diesel with 64%, followed by the gasoline with 27%, alcohol ranks third with 5.6%.

It is clear that particular attention should be given to the means of locomotion such as cars and private vans, given the importance they have on the final consumption of energy. In this sense, the possibility of implementing measures to improve the efficiency of specific consumption (for example, not allowing the importation of vehicles with an excessive age) should be analyzed, promoting eco-driving and improving the accesses and roads in important cities to avoid congestion, among other alternative measures.

![Figure 3. Net energy consumption by sectors.](image)

Finally, it should be noted that according to the BNEU, in terms of useful energy, consumption in the transport sector amounts to 296.7 kTep. This implies an average yield of 22% (total useful energy/total net energy). This value is similar to the average of other countries (for example in Peru...
with 22%, Uruguay with 22.3% and in the Dominican Republic with 20%). In the specific case of Paraguay, the average value bias to a figure close to 24% (average diesel yield) is due to the high weight of diesel consumption on the total energy demand in the transport sector.

3.1.2 Residential Sector

The residential sector is the second net energy consumer sector, with 28% of the total. Fuelwood and charcoal account for 71% of the sector’s net consumption. This clearly indicates the enormous potential for replacing these sources with higher quality ones, such as electricity; and at the same time the significant saving potential of introducing more efficient appliances, in particular in the use of energy for cooking.

Fuelwood becomes more important as an energy source as household income decreases, and with greater impact if households are rural.

Electricity is the second most important source with 22% of the net consumption of the sector and 60% of the useful consumption. In turn, electricity is allocated 26% to food preservation, 20% to water heating, 19% to room cooling and ventilation, and another 19% in other artifacts. These uses should be considered as priorities for the implementation of energy efficiency measures.

The electricity coverage of Paraguay is 98.53%, according to data from the statistical summary of the ANDE, to the year 2013 [6]. Therefore, all households have access to electricity, except in the rural low-income sector, where the electrification of this group is 97.9% (estimated at 2,850 households without access to electricity) [7]. However, despite the almost universalization of access to electricity, it has asymmetries: Low Income households consume only the equivalent of 14% or 11% of high income households, depending on the urban or rural environment, respectively.

In 2011, the residential sector of Paraguay consumed a total of 453.4 kTep of useful energy. This indicates an average utilization performance of the sector of 32.7%. The first notable difference in the analysis of consumption in useful energy in relation to net energy consumption is that the main source of useful energy consumption is electricity, with 60.2% of the total (Figure 4). Now, fuelwood accounts for only 21.4% and charcoal 9.2% of total useful consumption. This significant difference in relation to the structure of the consumption in net energy is due to the great difference in the yields of average use of the artifacts that consume each source. Liquefied gas now ranks third, after electricity and fuelwood, with 8.8% of useful consumption.

Figure 4 shows the participation of each source in the useful consumption of each use, basic information for the analysis of substitutions between sources, including the potential penetration of new sources. As is common, the greater competition between sources occurs in so-called "caloric uses": cooking, water heating and heating. In cooking, most of the useful energy is provided by firewood, with 47.6% of the use, followed by liquefied gas (21.6%), charcoal (5.4%) and electricity (9.3%), respectively.
In water heating there is a preponderance of electricity in the useful consumption of the use, with 80.1% of the total, followed to a lesser extent by firewood and charcoal. It is noteworthy the low participation of liquefied gas, where the high relative costs of equipment (water heaters and hot water tankers) are one of the factors that conspire in the penetration of this source in this type of use. It should be mentioned that the main appliance used to heat water is the electric shower, with a much lower equipment cost.

The use of heating has very little relevance in the country, and the same is attended mostly by electricity in 45.1% and firewood in 49.4% of its useful consumption. In terms of useful energy, cooking food is still the main use with 39.8% of the useful consumption, as shown in Figure 6.
3.1.3. Industrial Sector

Industry is the third largest sector in net energy consumption in Paraguay, 27% of national consumption. Biomass waste accounts for 44% of net sector consumption and 34% of useful energy; while firewood 38% and 45%, net and useful respectively. That is to say that 82% of the net consumption of the sector is provided by these two sources together. The residues are composed of 96% by bagasse and the rest by sawdust, coconut husk and others of very punctual consumption as rumen, residual oils and fat vaccine.

The main subsectors that consume net energy are food residues (49% of net sector consumption) and non-metallic (25%). The rest of the subsectors have shares lower than 6%.

The main use of energy is the driving force, with 42% of net sector consumption, followed by direct heat (31%) and steam (25%). It is possible to mention the high incidence of the consumption of bagasse in driving force of the sugar industry. In fact, if this consumption does not exist, the structure of consumption by uses of the sector would be greatly altered.

Given the values of energy consumption detected in this sector, the need for energy efficiency measures is highlighted. However, for a better estimation of efficiency potentials, energy audits should be used with greater statistical representativeness.

Analyzing the energy consumption of a sector in terms of useful energy means: firstly, to better evaluate the energy requirements for production represented by the uses of energy and, secondly, to allow a better comparison between the energy sources and technologies applied to a use, since they usually have very different utilization yields.

In 2011, the industrial sector of Paraguay consumed a total of 754.3 kTep of useful energy, which means an average utilization performance of the sector of 64.6%.

The structure by source of the useful energy consumption of the total of the industry undergo modifications in relation to the structure of the net energy consumption. Fuelwood now becomes the main source, with 46.2% of the total useful consumption of the sector. Biomass residues occupy second place with 33.5%, this decrease of 10% in participation is mainly due to the significant use of bagasse in the driving force of sugar mills, with relatively low utilization performance. Third, electricity represents 12.3%.

The main use in terms of useful energy consumption is direct heat, which consumes 34.2% of total useful consumption. Then, steam (33.0%) followed, driving force (31.0%), and with much less
process cold importance (1.3%), non-productive uses (0.7%), internal transport and illumination (0.1%) as shown in Figure 7. Electrochemical processes have practically no participation.

Figure 7. Share of sources in useful energy consumption - Total Industry.

This section presents the final results of the survey and expansion to the total country of energy consumption of the Agricultural and Forestry sector of Paraguay, as a result of surveys of consumption and energy use throughout the country, stratified into four Subsectors according to the main productive profile of the agricultural farms and segmented in three sizes.

Stratification by subsector was performed by dividing the establishments into four categories: Soy, Maize and Wheat, Forage/Cultivated Pasture, Forest and Rest of the Agricultural. The stratification criterion is based on the pattern of differentiated consumption that this typology of farms presents with each other, being the soya maize and wheat operations in general more demanding of mechanization for having more work during the annual campaign in comparison to the crop of Forages and Pastures. The pattern of consumption of the Forestry sector is markedly different from the other farms, and lastly in the Rest of Agriculture were included those farms that could not be clearly identified with any of the typologies described.

The categorization of a farm in the Soy, Maize and Wheat subsector corresponded to those farms where the cultivated area of these three crops exceeded 55% of the total cultivated area of the establishment according to the Agricultural Census of 2008. The same criterion was used to categorize the Forage/Cultivated Pasture subsector but with the total accumulated percentage in species of this type and in an equivalent way with the Forestry sub-sector in which the forest species were used for cutting. The Rest of Agriculture subsector included farms that were not included in any of these ratings, since they had a greater diversification in their productive structure.

Once the establishments were separated according to the defined subsectors, it was stratified within the same according to a criterion of cultivated area, dividing the farms in Small, when the surface did not surpass the 100 Ha cultivated, in Medians when it was greater or equal to 100 Ha but less than 1,000 Ha and big when the cultivated area exceeded 1,000 Ha. These cut ranges were modified for the Forage/Cultivated Pasture subsector as they improved the statistical indicators by reducing the variance within the homogeneous modules. Reasonable fact therefore among the farms dedicated to the breeding of livestock with forages and cultivated pastures shows an average exploitation size greater than in the other subsectors. They were taken to 150 Ha and 3,000 Ha to segment between Small, Medium and Large farms.
This sector accounts for 7.5% of the country’s net energy consumption. The weight of tractors and mobile machinery in energy consumption is the most relevant, reaching 64% of the net consumption of the sector. This use is practically captive of the diesel. The technologies to gasoline, some relieved, do not reach 0.1% of the consumption. Among the tractors and mobile machinery, in recent years has seen a significant penetration of self-propelled harvesters and seeding machines. In fact, while machines with more than 10 years their share in consumption was 2%, the machine represents about 12% between machines up to five years.

From the point of view of the consumption by sector, farms categorized as soybean, maize and wheat together with those in the forage and cultivated pastures category represent 90% of the sector’s consumption. In terms of acreage (according to 2008-2009 census data [7]), they represent 91% of the area and 32% of the farms. Based on data from the same census, it was estimated that the share of direct sowing in soybean corn and wheat represented 70%. However, both the data reported in the field work and the opinion of qualified informants revealed a shift in these proportions, with direct sowing accounting for just over 90% of the total of these crops. Therefore, large decreases in diesel consumption are not expected in the future due to the change in the type of sowing.

The intakes per hectare surveyed are consistent with this change since they were calculated in 25 liters/Ha, values consistent with direct sowing. In this respect, on farms where forage and pasture farmed more than 55% of production, a consumption per hectare of 19 liters/Ha was reported, which is compatible with activities in which less agricultural work is required, either by lower weight of the defense or frames left for the grazing of animals that are not harvested. The second type of consumption in order of importance is linked to the use of heat with 21% of the net sectoral consumption, in which the heating in animal hatcheries and the drying of grains stand out. Fuelwood is the predominant fuel used in this use. In terms of the useful energy of the agricultural and forestry sector, Paraguay consumed 107.4 kTep, which means an average utilization of the sector of 33.5%.

3.1.5. Sector Commercial, Services and Public

This sector has relatively low energy consumption, only 5.5% of the total net consumption of the country. Of the six energy sources used in the sector, consumption is highly concentrated in electricity, which contributes 96% of its net consumption. Wholesale and retail trade is the subsector that accounts for the bulk of net energy consumption (43%), followed by hotels and restaurants (21%). The other subsectors have rather smaller shares.

The main use for electricity is cooling and ventilation of environments (29% of the electricity consumption of the sector). They are followed by lighting (20%), food preservation (19%), and other artifacts (12%).

It is concluded that much of the energy consumption in this sector is represented by captive uses of electricity and energy efficiency measures should be geared to the modernization of the devices used in these uses: for example, refrigeration and ventilation of environments only 40% of the equipment is less than 5 years old and in the case of food preservation 50% of the park has less than 5 years, which would improve the efficiency in lighting (both by changing to luminaries more efficient as by lighting management measures).

Regarding energy, in 2011, the total of the Commercial, Public and Services Sector of Paraguay consumed 158.05 kTep of useful energy, representing an average utilization performance of the sector of 66.2%. The high average performance observed in this sector is explained by the relative importance of the use of electricity, where the equipment used has high efficiencies. In the case of useful energy, Electricity participates with 98.2% (see Figure 8).

Figure 9, shows the participation of each source in the useful consumption within each use, basic information for the analysis of substitutions between sources including the potential penetration of new sources. The biggest difference between sources is in cooking, other artifacts and internal transportation, where at least three energy sources compete. On the other hand, in water heating, the difference is observed mainly between electricity and firewood, whereas lighting, heating, food
preservation, refrigeration and ventilation, water pumping and power are all captive uses of electricity.

![Pie chart showing energy sources](image1)

**Figure 8.** Share of the sources in the useful energy consumption - Total Commercial, services and Public.

![Pie chart showing energy uses](image2)

**Figure 9.** Share of sources in useful energy consumption - Total Commercial, Services and Public.

### 3.2. Main results of the 2013 update of the National Balance in Useful Energy

As a complement, the main results of the update to the year 2013 of the Energy Balance in Useful Energy used for the elaboration of the National Energy Prospective, base for the formulation of the Energy Policy Paraguay 2040. This update was obtained through an analysis which is based on the National Energy Balance of Paraguay, prepared annually by the Vice-ministry of Mines and Energy (VMME), and making adjustments to the expansion factors of the surveys carried out in 2011.

The percentages of participation of the different energy sources in the final consumption can be seen in Figure 10, it is observed that in comparison with the results of the year 2011 there is a decrease in the participation of firewood (-2.9%) and (-1.8%), and an increase in electricity

![Energy use distribution](image3)
consumption (+3.5%), and liquefied gas (+1.4%). The imbalance mentioned above, with a high share of biomass, energy sources based on imported oil and limited electricity penetration remained.

![Final consumption of net energy by sources - Paraguay.](image)

Paraguay's total net consumption in 2013 was 4,684 kTep. The main source in net consumption was firewood with a 24.4% share; then the diesel is placed with 23.4%; and electricity with 18.8% respectively. In other words, these three sources accounted for 66.6% of total net consumption.

With regard to useful energy, electricity is the main source used, with 34.3% of total useful consumption (1,892 kTep). Then the fuelwood follows, with a 23.9% share. Third is diesel, with a share of 13.9%. This significant change in diesel share in relation to net energy consumption is due to its low average performance compared to electricity: 24.1% versus 73.7% respectively. The low yields of the diesel are due to its main consumption is in the transport, in tractors and mobile machinery of the agricultural and forestry sector.

Vegetable waste has increased its share of useful energy consumption, remaining at 14.9% of total useful consumption. This is due to its average yield of 49.3%, higher than the average of total use that reaches only 40.4%, as shown in Figure 11.
4. Conclusions

Throughout the analysis, different diagnoses of the energy sector in Paraguay are shown, taking into account biofuels, hydrocarbons, electricity and biomass, preferably. Also, the most relevant results of the analysis of the National Energy Balance are shown. As can be seen in the analysis presented, the country’s energy problems are feasible to be solved with adequate planning, since the country has an adequate amount of natural resources for self-sufficiency and there is sufficient potential for improve the processes involved in the production chain of the energy sector.

In addition, with the results of the Energy Balance update in the year 2013, it is evident that the transition from the use of less efficient sources (biomass and petroleum products), to more efficient sources (electricity), is developing, but in a way very slow, due to the lack of concrete actions that encourage this transition. However, with the execution of the action plans outlined in the Energy Policy until 2040, Paraguay will be able to significantly improve the situation of the energy sector and achieve adequate sustainability indicators for its Energy Mix.

References


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