SEA of the inclusion of renewable energies

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ABSTRACT

A strong dependence of fossil fuels characterizes the electrical argentine sector. In recent years, have verified some progress in relation to the introduction of energy from renewable sources by changing the legal framework, subsidies for research, product development, etc. although it is still far from being an important sector within the matrix. As part of a SEA for the inclusion of renewable energies into the matrix, this paper includes significant information and set of data for each of the natural resources and their potential for energy production throughout the country: thermal solar, photovoltaic solar, wind power, biomass, mini hydraulic and wave energies. Finally, it presents an analysis for implementation of the various technological options and some environmental impacts.

Summary Statement: This paper discuss the possibility of introducing renewable energy into the matrix by including data for each natural resource and its potential for energy production in some ecoregions of Argentina.

Key words: electric energy, renewable energies, environmental strategic assessment (SEA)

1. INTRODUCTION

1.1. Electrical Argentinian System

A strong dependence of fossil fuels characterizes the electrical argentinian system. Until July, 2016 the power (equipment) installed in the Argentinian System of Interconnection (SADI) has been little diversified. Three big groups can be distinguished, in agreement to the natural resource and to the technology that they use: Thermal Fossil with 60.08 %, Hydraulic with 33.96 % being the principal skeleton that supports the functioning of the Electrical National System. The Nuclear technology contributes 5,36 % and between Wind and Photovoltaic energies do not reach 1 % of the total. (Fig.1)

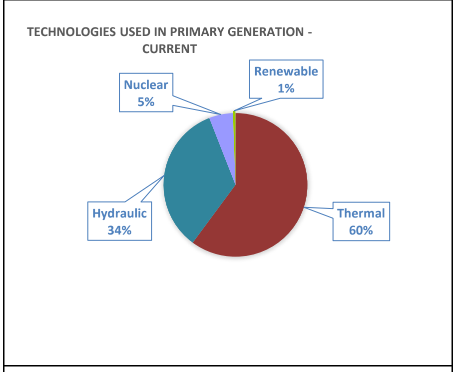


Figure 1: Current technologies used in primary generation

The Thermal Fossil sector, in turn, can be subdivided into four classes, in agreement with the type of thermal cycle that they use to take advantage of the energy: steam turbine, gas turbine, combined cycle, and diesel engines.

The poor incidence of the renewable energies is very distant from the aims raised by the Law 27.191, sanctioned in September 2015, which fixes as targets that national electricity company reaches an 8 % of the energy consumption to 12/31/17 and a 20 % on December 31st, 2025.

1.2. Argentinian System of Interconnection (SADI)[1]

The electrical system is shaped by generating factories of electricity, electrical lines of discharge and extra high tension, electrical networks of distribution and by diverse consumers of electricity (residential, industrial and commercial). This system does not store electrical energy, which means that at all times the generation must be equal to the demand or consumption of the market, making necessary the export of the surplus.

[1] Previously denominated National Interconnected System – "Sistema Interconectado Nacional (SIN)"

All the elements and facilities of transmission, compensation and maneuver integrate what is known as Argentinian System of Interconnection (SADI), shaped by the High Voltage Transport System and for the Systems of Transport for Main Distribution of the different electrical regions of the country. The equipment installed in the SADI commercializes its generation of energy on the Electrical Wholesale Market (MEM) being administered by CAMMESA (Wholesale Electrical Market Management Company).

1.3. Greenhouse Gases (GHG)

Figure 2 shows the evolution of the electricity generation by technology, where the strong dependence on fossil fuels is observed. Obviously, the increase of the GHG accompanied the evolution. Within the fossil fuels, the principal generator is the Natural Gas (GN). The utilization, from 2010 of Generators of Combined Cycle, using as fuel, mainly fuel oil and diesel oil, has taking place the increase in the last years. Though the emission of GHG related to the electrical Argentine sector is scarcely 0,6 % of the world total of this sector, it will be necessary to realize efforts locally to comply with global targets.

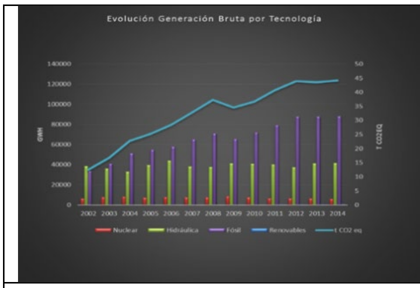


Figure 2: Electric generation evolution by technologies (nuclear-hydraulic-thermal fossil-renewables-t CO_2 eq) CAMMESA. 2014

1.4. Strategic Environmental Assessment (SEA)

Strategic Environmental Assessment: Due to the conformation and evolution of the SADI, it is considered indispensable to evaluate, from an environmental and strategic point of view, the modification of the energetic matrix of the next years, taking into account, apart from the incorporation of new renewable sources of generation, the introduction of the distributed generation system.

The scope of present SEA will be national. The Strategic Environmental Diagnosis will be carried out through the conformation of homogeneous regions, taking into account specific indicators.

The area in which the present SEA is developed is the academic level and it includes stages of participation and consultation with the directly involved sectors, whether from the private or official sector.

Stages: First stage presented in the present work. In the second stage (not included here), we will have analyze the economic, labor and tariff impact, especially regarding distributed generation.

1.5. Distribuited Generation

The impact of renewable energy sources on electricity generation is due to large-scale forms of generation (solar farms, wind parks, etc.), called "centralized generation" also on a small-scale (solar residential facilities, low power wind turbines, etc.), called "distributed generation".

Typically, the first one develops in places far from the points of consumption while the second one develops in places closer to them, being a particular case the "microgeneration" where the generation is located exactly in the points of consumption.

Government policies of promoting the utilization of renewable energy sources, likewise, can be directed towards one or another form of generation.

1.6. Regulatory Frame

The current Argentinian National Electricity Regulatory Framework is based on Law 15.336 of September 1960 and its complement, Law 24.065 of January 1992. Both laws establish the general regulatory aspects for all activities within the electricity sector but by themselves are not a sufficient tool for the development of electrical power generation from renewable sources.

In Argentina, the SEA management tool is not regulated. The only antecedent of specific legislation is in the City of Buenos Aires, even as a project law.

With regard to the regulations concerning Distributed Generation, began in 2013, in the Province of Santa Fe. Nowadays, six provinces have sanction specific regulatory framework.

2. METHODOLOGY

2.1 Selection of the spaces of implementation

The Argentinian territory presents a great diversity of environments with generate an important heterogeneity in the climatological characteristics. This, added to the cultural diversity of every region, influences directly the customs of the inhabitants, which define a level of activity that is reflected in the residential electricity demand.

The current regionalization of Argentina is based principally on administrative and economic factors. Therefore, a division will be carried out bearing parameters specially selected and correlated directly with the aim of this work.

The selection of the parameters used for the formation of the conglomerates have tried to include different related aspects, directly or indirectly, with the utilization of the natural resources as source of energy (Table 1).

Table 1: selected parameters for regionalization

PARAMETERS	
ECONOMIC AND SOCIAL	Per capita mounthly income
	Annual electricity consumption
ENERGETIC	Average annual radiation energy
	Annual wind power
CLIMATIC	Average annual temperature
	Average annual precipitation
	Annual potencial evapotranspiration

In order to avoid the overlapping effect, we made a previous analysis of principal components that reduced the quantity of variables. Later, the Cluster Analysis in strict sense was made and the proposed regionalization was obtained (Figures 3).

For Statistical Analysis, corresponding software InfoStat 2016 has been used.

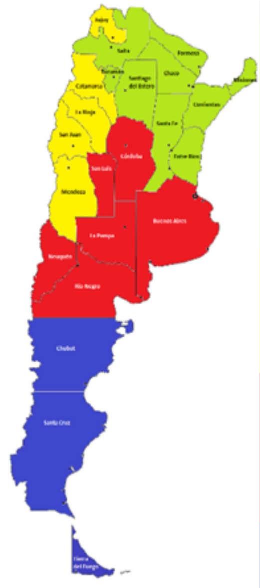
2.2 Energetic Potential

Solar Potential: Radiation and heliophania data were collected for each province from the Atlas of Solar Power (Rossi and Righini, 2007 and INTA, 2010). Then, an average was obtained between the values of summer and winter and, the theoretical average power per province have been from the area of each province. In this stage, 0,1% of each zone have been considered in order to calculate the generated possible energy.
Wind potential: has been considered to be equal or superior winds to 6.5 m/s, turbines of 2 MW and distributed in 0,1 for every km^2. (Mapa Nacional Eólico, 2009).
Wave potential: The principal parameters taken into account are the surface of submarine platform up to 350 miles from the Argentinian land coast, with a total of 2.821.103 km^2, waves between 2 to 2,25 m. of height in average and the devices Pelamos P-750 for the receipt of this energy. (Mapa Mundial Energético Undimotriz, 1991).
Minihydroelectric potential: For the calculation of the theoretical power, projects smaller than 30 MW were considered and those mini hydroelectric power stations that are in operation or out of service. (PROINSA, 2016). For the possible power, the 116 mini plants that are in project state have been analyzed.
Biomass Potential: In the case of biomass, it is separated into the five possible sources of the resource: livestock biomass, agricultural, urban solid waste, sewage effluents, and wood energy. (FAO, 2016. Charpentier, 2014, INTA, 2013, 2011. SENASA, 2014).

3. RESULTS AND DISCUSSION

3.1 Spaces of Implementation

The selection of the implementation spaces yielded the results shown in figure 3.
The following table 2 shows the general potential for electricity generation from renewable sources.



Región	Provincia
Boreal	Chaco
	Stgo. del Estero
	Santa Fe
	Formosa
	Misiones
	Corrientes
	EntreRíos
	Salta
	Tucumán
Poniente	Jujuy
	Catamarca
	La Rioja
	San Juan
	Mendoza
Naciente	Buenos Aires
	Córdoba
	La Pampa
	San Luis
	Río Negro
	Neuquén
Austral	Chubut
	Santa Cruz
	Tierra del Fuego

Figure 3: Space of Implementation

Table 2: Theoretical power, possible power and electric generation

RESOURCE	ZONE	THEORETICAL POWER (GW)	POSSIBLE POWER MW	GENERATION GWh/ annual
SOLAR	1	307.629	67.678	180.315
	2	531.794	116.995	274.594
	3	590.752	129.965	305.476
	4	281.709	61.976	113.641
TOTAL SOLAR		**1.711.884**	**376.614**	**874.025**
WIND	1	-	-	-
	2	-	-	-
	3	632	31.590	270.730
	4	1.139	56.945	488.015
TOTAL WIND		**1.771**	**88.535**	**758.745**
BIOMASS	1	1,92	1.498,10	10.499
	2	11,21	10.060,70	70.505
	3	6,57	4.480,30	31.398
	4	1,55	1.104,50	7.740
TOTAL BIOMASS		**21,26**	**17.144**	**120.142**
BIOMASS FROM USW	1	0,02	4,30	30,13
	2	0,05	18,30	128,25
	3	0,10	73,90	517,89
	4	0,00	1,80	12,61
TOTAL BIOMASS USW		**0,16**	**98,30**	**688,89**
MINI HYDRAULIC	1	0,23	126,20	482,09
	2	0,28	134,76	668,11
	3	0,24	117,76	357,94
	4	0,12	55,68	265,59
TOTAL HYDRAULIC		**0,87**	**434,40**	**1.773,74**
WAVES	1	-	-	-
	2	-	-	-
	3	704510	35226	61715
	4	1539355	76968	134848
TOTAL WAVES		**2.243.866**	**112.193**	**196.563**
TOTALS		**3.957.543**	**595.019**	**1.951.938**

In a first analysis, using very conservative indexes (e.g. in the case of PV solar energy production) it can be observed that the potential of renewable energies is enormous. For example, the possible potential is 1818 % higher than the installed current power and the generation of corresponding energy is more than eight times the current one (732 %). The most important of the resources in terms of magnitude of installed power is the wind one, even with the extreme restrictions imposed to the analysis.

We can also highlight that the zone most benefited by the energetic resources would be zone 4, located to the south of the country, with a 744,522 GWh of potential generation of electrical power, the majority being from wind resource. In this way, there would be a saving of 726 million tCO_2eq compared to what the current matrix would produce, mainly thermal. (Table 3).

Table 3: some results from the previous potentialities obtained.

Installed potency 2015 (CAMMESA)	32.729	MW
Possible potency	595.019	MW
Relationship possible / current installed	**1.818,02**	**%**
Maximun demand 2015	266.550	GWh
Possible generation	1.951.938	
Relationship possible / current	**732,30**	**%**
Solar + Wind 2015	195	MW
Solar + Wind possible	465.149	MW
Relationship possible / current	**238.538**	**%**
tCO2eq/GWh generation by CC and natural gas	726.120.913	t CO2eq
tCO2/GWh generation by Renewable energies	167.399	t CO2eq
Saving	**725.953.514**	**t CO2eq**

3.2 Alternatives scenarios

In Argentina's energetical scenarios by 2035 (Fernandez, 2015) organizations representing the country's technical and academic sectors, two scenarios of Electrical Demand Projection have been proposed.

- “Business as Usual (BAU)” projection: demand growth by 3.4% per annum
- "Rational Use of Energy" (ERU) Projection: demand growth by 1.9% per year

In the BAU scenario, demand for electrical power has been estimated by 251,040 GWh in the year 2035. The total installed power required to supply the above demand is estimated at 73.1 GW by the year 2035 (average load factor of 70 %), implying an increase of 130%, associated with a growth rate of 3.9% per annum. The difference in favor of the URE is a saving demand for accumulated energy efficiency, by 20 % in 2035.

Regarding the UBA matrix proposal, made by the Energy and Environment Group of the Faculty of Engineering, due to the existence of multiple alternatives and technological combinations, the minimization of the cost of electricity energy has been established as a main objective.

It is possible to observe, that the notorious participation of the renewable energies corresponds to a decrease of the thermal option, fundamentally. (Figures 4 and 5)

Associated with the above, there are substantial improvements with respect to the production of Greenhouse Gases (GHG) and total emissions. (Fig. 6). Calculation process was carried out by the LEAP system (LEAP, 2012).

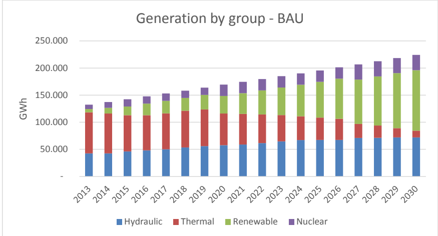


Figure 4: Electricity generation by technologic group, for the BAU scenario

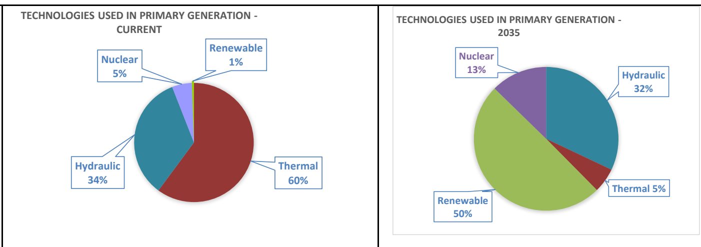


Figure 5: Electricity matrix. Actual situation and proposal for 2035

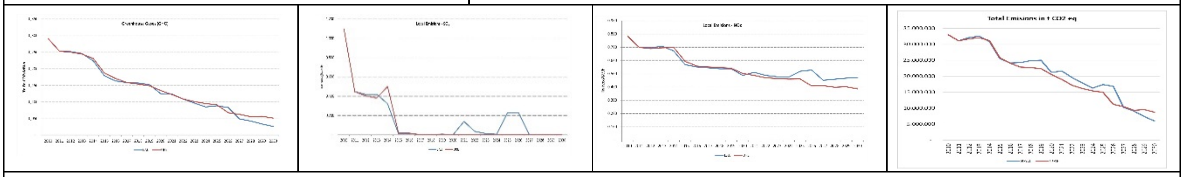


Figure 6: GHG, SO_2, NO_X emisions y total emisions in tCo_2eq associated with the new matrix proposed. www.escenariosenergeticos.org

4. CONCLUSIONS

The matrix for the generation of national electric energy is characterized by a strong dependence on fossil fuels. Lately, some progress have been made regarding the incorporation of renewable sources for electricity production, especially through the adjustment of the regulatory framework.

The analysis of the potential of the country for electricity generation from renewable sources strongly supports the proposal to modify the future energy matrix, contributing to diversification, decrease in GHG production and the non-dependence on natural gas.

In the next years, it will not only be necessary to change the composition of the energetic matrix, but also the generation and distribution models, by incorporating distributed generation and Smart Grids, in order to reduce transportation and distribution costs and improving the safety of the supply.

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