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A possibility of developing renewable energies for electricity production in Argentina

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Executive summary

In the first part, this paper presents the status of the energy market in Argentina with a focus on the electricity sector. After detailing its main characteristics, the situation of the market since 1992 is described, particularly with regards to new issues raised by the exhaustion of fossil fuels, the 2001 national crisis or the current world crisis. The waste of reserves that occurred at the end of the 90s led to a certain dependency. At the same time, both foreign and national investments fell, partly because of the national crisis. But the current crisis appears to be a breath of air which is a chance for the country to make up for lost time.

Therefore, in order to propose a transformation of the country's energy mix, various alternative energies are overviewed, such as nuclear energy, hydroelectricity or renewable energies; the opportunities to develop them in Argentina are being analyzed and compared. Nuclear energy and hydroelectricity would be relevant alternative energies, but concerning nuclear energy, Argentina does not have competences that are necessary to insure independency and to avoid negative externalities. Moreover both nuclear and hydroenergy need high investments from the beginning, and it will not be easy to raise them taking into account many similar projects faced (or not) in the past.

Then, the paper focuses on renewable energies, presenting their advantages and disadvantages and their current development in Argentina, which is very delayed with respect to other countries but also to the national law. Hence, the conclusion of the first part is that in Argentina the energy mix should be diversified by developing renewable energies.

In the second part, the paper analyzes some of the policies that were put in place to develop renewable energies in leading countries in Europe, Germany in particular: not only financial incentives have to be aggressive but also constraining legislation has to be really strong. Then it enlightens some positive consequences of the development of the sector in terms of jobs, for example, but also in terms of cost cutting-offs, as experience or R&D help to improve profitability.

After focusing on national policies concerning renewable energies, the current development of these energies in Argentina is presented, as well as the incentives that were established. In the light of the country's wind resources, the paper intends to show how and why wind energy should be developed by changing some policies or incentives. There are various barriers that can slow down the process and a focus is made on how these barriers could be pulled down. To finish, the benefits in matter of costs are studied, comparing profitability with respect to a potential investment in wind energy or investments that were made in other types of energies.

After a brief summary of the key points, either facts or recommendations, the reader will find a short conclusion that widens the renewable energy topic to the whole South American continent and ends with an opening to the other great asset of the country: the solar resource.

Resumen

En este artículo se analiza el estado del mercado energético en la Argentina, con especial interés en el sector eléctrico. Luego de analizar sus principales características, se revisa su evolución desde 1992 a la actualidad, tomando en cuenta los escenarios surgidos del agotamiento de las reservas de hidrocarburos, la crisis argentina del año 2001 y la actual crisis mundial.

Con el objetivo de evaluar las posibilidades de transformación de la matriz energética del país, se consideran fuentes alternativas como la energía nuclear, la hidroelectricidad o las energías renovables; se analizan y comparan también las posibilidades de desarrollo de cada alternativa. En lo que respecta a la energía nuclear e hidroeléctrica se evalúa las dificultades de inversión que ambas presentan y, en el caso de la energía nuclear, las competencias especiales requeridas. En tanto que en lo referente a las energías renovables se evalúa la debilidad de las políticas e instrumentos destinadas a su desarrollo en el país.

En segunda instancia, el artículo analiza las políticas de promoción en la materia llevadas a cabo en algunos países europeos –en particular Alemania- para el desarrollo de las energías renovables. Estas experiencias indican la conveniencia de que estímulos financieros sean agresivos y que debería contarse con legislación específica en la materia.

Luego se trata el estado actual del desarrollo de las energías renovables y las medidas de estímulo vigentes. En función de los recursos eólicos que el país posee, en este trabajo se intenta demostrar cómo y por qué la energía de ese tipo debe ser desarrollada en el país a partir de una modificación en las políticas de incentivo. Al existir diversas barreras que pueden demorar el proceso de cambio energético, se proponen alternativas para evitar los retrocesos. En última instancia, se evalúan los beneficios en materia de costos, a partir de la comparación entre la rentabilidad de una inversión potencial en energía eólica y la rentabilidad obtenida con otros tipos de energía.

Finalmente, y luego de resumir los ejes centrales desarrollados en el artículo, el lector encontrará una breve conclusión que intenta ampliar la temática de la energía renovable a Sudamérica y consideraciones preliminares sobre la otra gran oportunidad en materia de desarrollo energético de la Argentina: la energía solar.

I. THE NEED OF DEVELOPING ALTERNATIVE ENERGIES IN ARGENTINA

Introduction

« Without electricity, there is no development » say the International Energy Agency in its last report, the World Energy Outlook 2009, published on november, 10th. But the IEA points out the fact that according to its forecasts, coal, oil and natural gas will still be responsible for 80% of world's energy consumption in 2030 and more than three-quarters of the increase of energy consumption by then, while the average global temperature would increase by 6 Celsius degrees by 2100, « causing irreparable damage ».

The IEA calls for the development of wind energy, solar, biofuels, nuclear and capture and storage of CO_2. « We need a clear signal to encourage the deployment of low-carbon technology » says the Agency. This deployment should furhtermore strengthen the security of the supply.

« Each year that passes reduces the window of opportunity » and « increases the cost of transforming the energy sector » warns the IEA. Thus, the first study will concern the status of the energy sector in Argentina and to what extent Argentina can participate in transforming the world's energy mix and fighting against global warming.

1. The situation of the electricity market in the country

a. Definition

At the end of the 80s, the electricity sector was critical, as it was confronted to various major issues : even if the theoretical installed capacity was in excess, the availability of the thermal facilities (70% in 1987 an 50% in 1991[1]) was very low ; this was due to the low levels of investments, and a high rate of evasion of the users (in 1992 about 27% of the electricity introduced in the grid was not invoiced).

That led to the most important reform of the institutionnal system of the electricity sector ; indeed, the **Ley 24.065/92** modified the previous **Ley 15.336/60** that organized the sector. The aim was to solve these various issues but also to improve the competition and the consumer's service. The sector was divided in three parts : generation, transport and distribution. This repartition is currently common in developed countries. Tranport and distribution were defined as « public services », whereas the production was opened to free competition between public or private actors.

The MEM (Mercado Mayorista de Energía Eléctrica) is were the supply and the demand converge to define the price of energy as the marginal cost of the last facility necesary to satisfy the demand. But the demand is growing and there is always a risk that the supply could not satisfy the demand. This risk is implemented in the total price, by an additional price whose aim is to stimulate the supply.

The institutional architecture of the MEM can be divided in 3 parts :

- **The Secretaría de Energía (SE)** that establishes the policies of the sector and the rules and regulations of the market.
- **The ENRE (Ente Nacional de Regulación de la Electricidad)** that controls the service and the new regulations, but also prevents monopolistic behaviours, fixes the basis of the calculation for the sale prices, and take in charge the taxation.
- **The CAMMESA (Compañía Administradora del Mercado Mayorista Eléctrico S.A)** that is in charge of the operation and administration of the market, for example to optimize the production with the aim of minimizing the total costs, to improve the safety of the electricity market and the quality of its supply, to planify the needs of energy for the future, to estimate the prices on the short term, to emit electricity bills, but also to guarantee the transparency and the equity of the decisions within the MEM.

A **Fund of Stabilization** was also created to compensate the prices between the consumer's prices and the producer's cost. Indeed, the cost of the generation is constantly variable (depending on various factors, from fuels prices to weather

[1] Panorama del Sector Eléctrico Argentino, Ing. Héctor Marcelo Gonzáles, Secreteria de Politica Economica, Dirección Nacional de Inversion Publica, Agosto de 2007.

conditions), but the prices for the consumer cannot change every day and therefore, have to stay stable for a certain period of time : the prices are fixed every 6 months. The differences (positive or negative) are covered by the stabilization fund, that is negative since june 2003 and whose deficit exceeds $US 400 millions since august 2005[1].

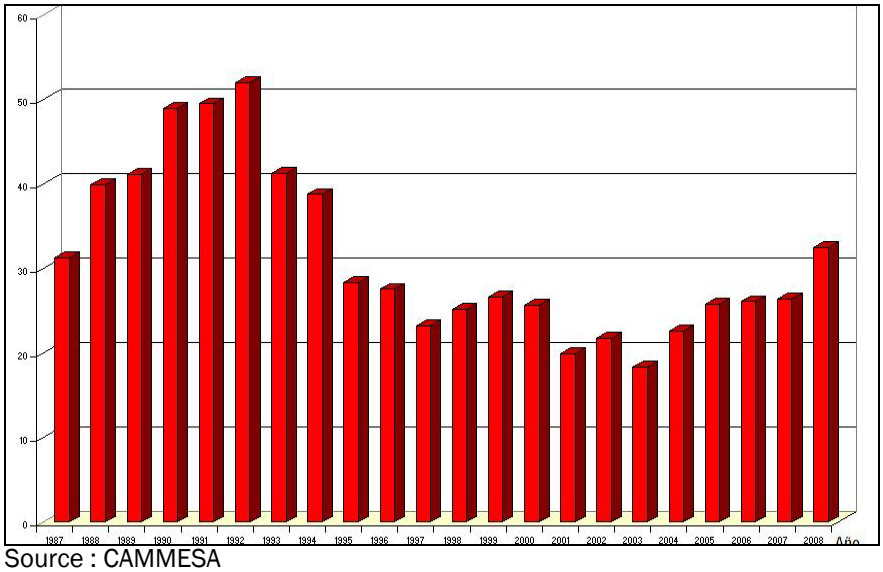
b. Situation of the market from 1992 to 2008

The privatization allowed to improve certain aspects of the market.

The electricity demand grew at a speed of 5,2% per year between 1992 and 2005 (although this growth was not homogenous). This was not only due to the increasing number of consumers : in 1992, the users of the MEM were 9,5 millions for a consumption of 37.667 GWh and in 2006, they were 12,7 millions for a consumption of 103.815 GWh. In 14 years, the amount of electricity consumed per year and per person dobled, increasing from 3.965 kWh/yr/person to 8.169 kWh/yr/person, showing how the economic growth is an essential factor.

This resulted in stimulating the supply by investments that totalized US$ 6 billions (1992-2006). In 1992, the electricity generation capacity was 14.1 GWe with an unavailability[2] of the facilities of about 52%, whereas in 2008 the capacity reached 26.6 GWe with a high rate of availability (around 70%).

Argentina : termical unavailability from 1987 to 2008 in %



Source : CAMMESA

This growth allowed Argentina to satisfy the internal demand but also to export energy to adjoining countries. 12 heat generation power plants were installed, each producing energy with a high efficiency in the use of hydrocarbons (using combine cycles) and a reduced rate of greenhouse gases emissions[3].

[2] The unavailability of the facilities is mainly due to situations of programed or forced maintenace, but also for restriction of combustible.

[3] The « combine cycle » power plants use the heated gas that goes out the first turbine to introduce it in a secondary turbine ; it reduces the contamination as well as it improves the efficiency, reducing the heat losses.

As for the supply, in average it is composed of 40% hydraulics and 50% termics (with natural gas as the main combustible). The SADI (Sistema Argentino de Interconexión) concentrate over 95% of the supply of the sector that reached a capacity of 24.000 MWe in 2006 for a maximal demand of 18.345 MWe in 2007[4]. But the calculation of the effective capacity, which take in account the unavailability[5], gave 19.200 MWe, which represented an ability to cover an increase of the demand of about 5%. This margin is undeniably too short. Indeed **it is just sufficient to cover the average demand's growth in one year, whereas safety measures as well as a vision on the long term should encourage Argentina in forecasting the growth a lot more time in advance, especially if the country wants to preserve its energy independence.**

Concerning the investments in the MEM, during the 1992-2006 period most of them correspond to combine cycle power plants (6.600 MWe), and the rest concerns hydrolics (2.650 MWe). The transformation of vapor or diesel turbines in gas turbines also participated in reducing the level of unavailability.

Nevertheless, the national crisis of 2001 showed that the model of the privatization was not sustainable, as it did not only happened in the energy sector, and was partly responsible of the fall of the economy; concerning energy, the high investments made between 1992 and 2000 led to an accumulated excess of supply, which involved a fall of the prices and therefore, a decrease of the profitability of the newests power plants. This resulted in a decrease of investments. The private investors terminated their contracts with the State. Most of the foreign investors left the country and local investors did not sign other contracts. That led to a stagnation of the national capacity for several years.

Private participation in infrastructure projects

(annual averages)

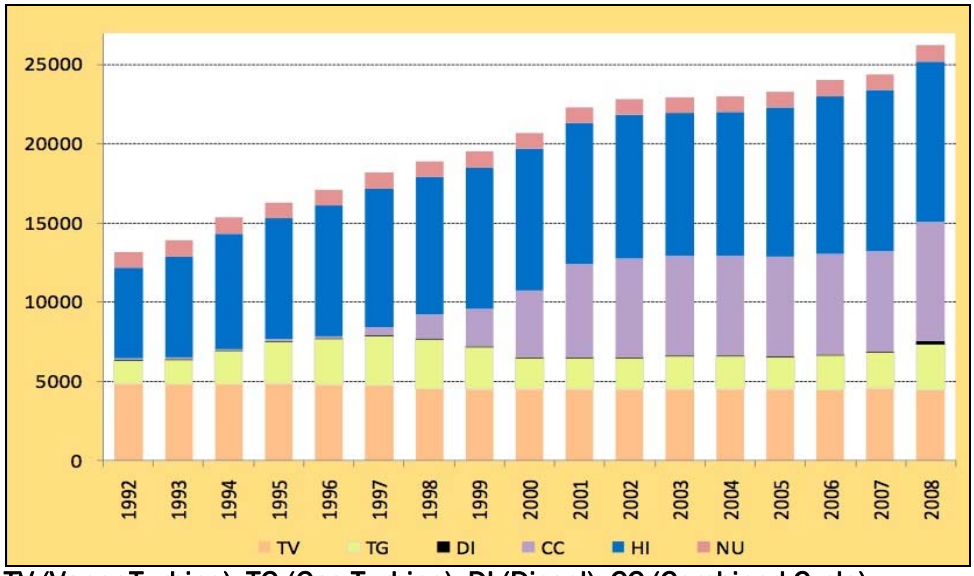
	1990-2000		2001-2007	
	US$ millions	Number	US$ millions	Number
Energy	2.248	8.2	586	1.0
Telecommunication	1.971	0.6	867	0.0
Transport	1.148	5.2	163	1.7
Water and sanitation	734	1.6	15	0.1
Total	6.100	15.6	1631	2.8

Source: Datas from the World Bank's PPI Database (http://ppi.worldbank.org/index.aspx)

[4] Historical maximum the 22d of July, 2009 with 19.566 MW (Syntesis del MEM de julio de 2009 - CNEA).

[5] The difference between nominal capacity and effective capacity is given through the average factor of availability of the last 10 years (0,75).

Evolution of installed capacity for various types of energy (in MW)



TV (Vapor Turbine), TG (Gas Turbine), DI (Diesel), CC (Combined Cycle), HI (Hydrolics), NU (Nuclear)
Source : Cammesa

But hopefuly the demand's growth also slowed down. Indeed, during the period 1992-1998 the demand grew at a speed of 6,3% per year, whereas between 1998 and 2002 it grew at only 2,4% per year to end up finding a new growth between 2002 and 2005 at a speed of 6,7% per year[6].

In 2002, the government decided to change the regulation of the prices. From the fixed price extracted from the cost of the energy generation of the marginal facility, the system now runs with variable costs concerning the heat generation power plants, which means that the prices depend of the way the electricity is produced in each power plant, and therefore, of the type of combustibles it comes from. It also established a maximum price of 120 $US/MWh.

PBI and energy demand / Period 2008 vs 2001

PBI at the market prices[1]	**43%**
Generation of electricity[2]	**43%**
Demand of Natura Gas[3]	34%
Sales GNC[3*]	43%
Sales Gas Oil[4*]	26%
Sales Fuels[4*]	30%

[1]Indec. [2]Cammesa. [3]Enargas. [4]Secretaria de Energía.
[*]Sales en physical volumes

[6] Calculation from datas fournished by the Secretary of Energy and the Ministery of Economy.

The previous datas show how Argentina fund a new growth after the crisis of 2001. Moreover, the growth of the energy supply is highly correlated with the economic growth.

Moreover, the **National Energy Plan 2004-2008** established and aproved in 2004 planed investments whose estimation is US$ 3.845 millions but also affirmed the necesity to increase energy exchanges with adjoining countries. The « Fund for necesary investments that allow increasing the electricity supply in the MEM (FONINVEMEM)[7] » was also created by the government in order to built two combine cycle power plants[8] for a capacity of 1657 MWe for 2008-2009 ; today they still operate with only half of their capacity. The creation of this fund showed that the government and the private companies recognized the risk run by the electricity sector in Argentina as well as the difficulty to find investments in the private sector. Indeed, the fund was partly alimented by the generation companies[9] that owed to the CAMMESA through the Fund of Stabilization, but also with some investments made by other companies that did not have any debts[10].

Electricity generation facilities of the MEM installed (end of August 2009)

GWe Installed	Thermics	Hydrolics	Nuclear	Total
Region NOA	2,1	0,2	0	2,3
Region NEA	0,1	2,0	0	2,1
Region Centro	0,7	0,9	0,6	2,3
Region Cuyo	0,6	0,9	0	1,5
Region Bs As	10,3	0,9	0,4	11,6
Region	1,3	4,6	0	6,0
Region	0,3	0,5	0	0,8
Total	15,4	10,2	1,0	26,6

Source : CNEA – Sintesis MEM agosto 2009

The installed capacity started growing again in 2008, with the opening of these new thermo plants. Nevertheless, one is still producing half of its future capacity, even though it was supposed to work entirely for 2008. Furthermore, these two power plants do not seem enough to recover the lack of new facilities since 2001. Even though other projects were recently inaugurated[11], their capacity is low. Thus, if we consider that the demand will continue to grow at the same speed of about 4,8% per year, **in the short term, Argentina needs at least a new 900 MWe power plant per year**. In the long term, it may be even more.

Moreover, we can observe that the localization of electricity production is very unequal between regions, Buenos Aires monopolizing almost half of the country's production. For example, despite of its abundant resources, either hydrolics, wind or solar, the Province in which the activity of electricity generation is less developed is Patagonia, with a nominal production if 0,8 GWe. This is due to the fact that **the high voltage line that links**

[7] Fondo para Inversiones necesarias que permitan incrementar la oferta de energía eléctrica en el MEM.
[8] *Termoelécrica San Martín* (TSM) in Timbúes, in the provincia of Santa Fé (capacity 830 MWe) and *Termoelécrica Manuel Belgrano* (TMB) in Campana in the provincia of Buenos Aires (capacity 827 MWe).
[9] Principally AES, Endesa, Petrobrás Energía and Total.
[10] CMS and Generadora Córdoba, among others.
[11] In June 2009 started the hydro central of *Caracoles*, in San Juan (capacity 125 MWe) and in july the *Genelba Plus* power plant, in Marco Paz, brought 165 MWe more.

Patagonia to the SADI[12] was installed only two years ago. Now that it has been started, the possibilities of generating electricity that would be directly implemented in the electricity grid have to be developed.

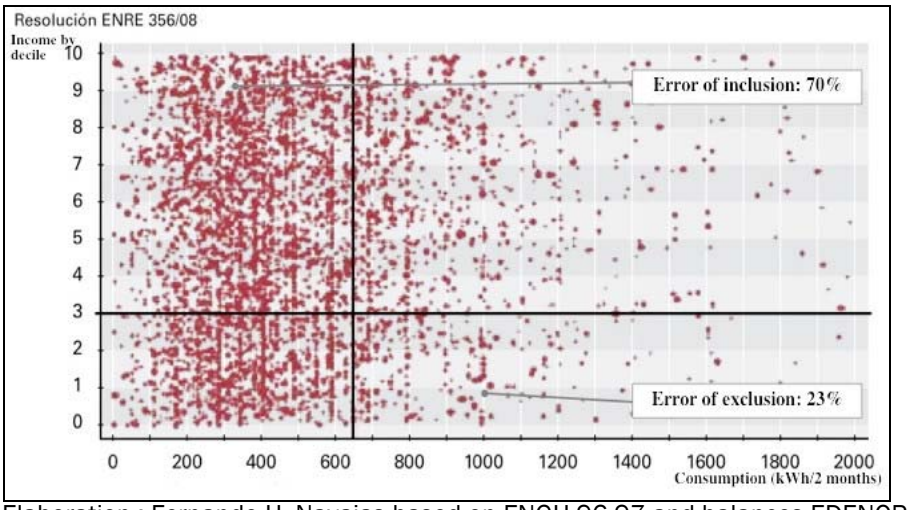
High voltage lines of the SADI

Source : Cámara Argentina de Energías Renovables

Currently, Argentina also find itself in front of the issue of subsidies. Indeed, the State provides subsidies for all energy consumers. In despite of the decrease of the activity and the fall of the international energy prices, in the first nine months of 2009, the subsidies of the National Public Sector increased by 12%, totalizing $ 25.212 millions and it is estimated at $37.000 millions for the all year[13], which represents 3,4% of the PIB, a little more than the $35.000 millions spent in 2008 which represented 3,3% of the PIB. By comparison, in 2006, the subsidies totalized $ 4000 millions and in 2007, they were over $ 8300 millions[14]. Yet, the proportion of subsidies destinated to the energy sector have significantly decrease as they currently represent 40% of all the subsidies whereas they represented 50% of them last year[15]. Nevertheless, the price finally paid by the consumer results to be very low with regard to adjoining countries[16], making the subsidies policy even less sustainable during months of high demand, when gas is being imported.

[12] The Sistema Argentino de Interconexión (SADI) is the national grid of high and low voltage electricty lines including the transformers. It connects principally the areas where electricity is generated to the urban and populated areas. For example, the Gran Buenos Aires represents 65% of the national demand but only generates 43% of the total and therefore has to import electricity from other Provinces, through the SADI.
[13] According to the estimation of the consultant Ecolatina.
[14] ASAP, report of february 2009.
[15] Clarín, October 14th, 2009.
[16] The average price in Latin America is more than 3 times the price in Argentina (87 $/MWh in 2008 according to Cammesa).

Repartition of households in function of their consumption of electricity and income



Elaboration : Fernando H. Navajas based on ENGH 96-97 and balances EDENOR and EDESUR 2007

Besides, the low prices, even if they maximize the wellbeing of the population in the short term, lead to high consumption and do not encourage any policy of rational use of energy within industrial firms[17]. Moreover, they do not encourage any improvement in the output of electric household appliances or technology. The international organisms are currently asking Argentina to raise the tariffs in order to reduce public expenditure. The International Monetary Fund (IMF) already had claimed this raise in its 2006 audit of Argentina's accounts. The subsidies being less and less sustainable, the government began to establish raises in the tariffs last year, with the **Resolucion 324/08 of the ENRE.**

Amount invoiced (without municipal or provincial taxes) and the price per kWh : comparison between the current tariffs and the ones that were effective before october 2008

Consumption (kWh)		475	725	850	950	1100	1300	2100	2850
Curent tariffs	Cost by semester ($)	45	63	74	80	166	199	414	869
	Price by kWh ($)	0.09	0.09	0.09	0.08	0.15	0.15	0.20	0.30
Previous tariffs	Cost by semester ($)	45	63	74	84	96	116	168	218

[17] In comparison, the brazilians pay twice as more for gasoline, 6 times more for electricity and 30 times more for gas.

	Price by kWh ($)	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08
	Increase (%)	0.0%	0.0%	0.0%	-4.0%	72.3%	72.1%	145.7%	299.0%

Elaboration : IAE « General Mosconi »
Source : ENRE

The social tariffs allowed to poor households that cannot afford the raises are calculated in reference to their electricity consumption[18]. But this model is far from being pertinent as this graphic shows it : 20% of the households that should benefit from the social tariffs are excluded, whereas 70% of the households that should not benefit from the social tariffs are included.

Yet, the current Secretary of Energy, Daniel Cameron, declared that in the frame of the polemical Decree 2067/08[19] which raises the prices for the high consumers of gas, « 95 or 96% of the users that are concerned by this measure are able to pay for their high conumption »[20]. Lastly, it does not seem fare to allow a social tariff to the poor gas consumers because the poorests consumers do not even have any access to the gas grid and actually buy gas bottles at a very high price, which would also have to be rebalanced. Thereby, the prices of energy remain a pending issue. The government can not keep on subsiding most of the population, because the energy sector requires more and more investments and the energy becomes more expensive. The model of general subsidies is undeniably unsustainable, and it seems pertinent to transform it to a system where the consumers pay for the energy they consume. That is why **the issue of social tariffs has to be solved ; the way of selecting the homes that could benefit from social subsidies could be changed, for example, instead of considering the consumption as a basis, a new basis could be the income, the household's location in a poverty area or the way of life, that would have to be evaluated precisely, case by case**. A possible way of reaching this purpose would be to request the households a declaration of income or a declaration of property (type of housing, car, television, computer, etc).

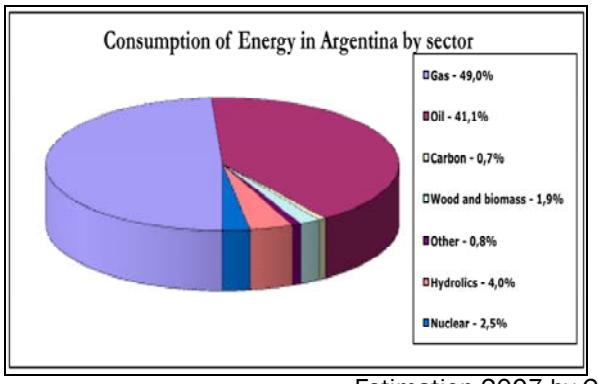
As the households only represent 29% of the electricity consumption, the issue also concerns other sectors. Indeed, the industrial sector is the biggest consumer with a 46% and the public and commercial sector represents 23% of the consumption[21].

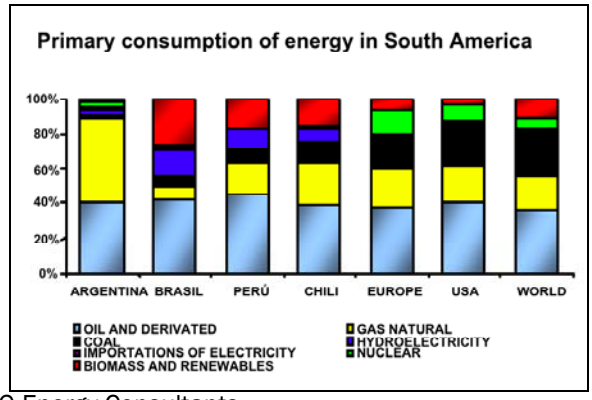
In conclusion, the current situation, in the country or in the world, raises two interrogations : on one hand, we can ask ourselves if the current global crisis had any impact on the growth of the energy demand in the country. On the other hand, **the crisis makes more clearer the changes of minds in the occidental countries regarding renewable energies, as most of these countries are in the process of developing renewable generation of electricity on a large scale**, but Argentina seems not to have taken these changes into account as it has started building new thermo plants whereas there is not any alternative energy project of large scale. Therefore, we will briefly study the impact of the current crisis, before pointing out the necessity of a real and active renewable energy policy for the country.

[18] The prices raised from 75% to 300% depending of the consumtion of households. Only the ones that consumed more than 651 kWh every two months were concerned ; in the Buenos Aires province, they represent 24% of the 1.600.000 households that recieve electricity from the distributors (Edenor, Edesur and Edelap).
[19] The raises were finally cancelled with the Resolution Enargas N° I/828 2009 after the controversy and the protests of the opposition and the money was reimbursed to the consumers.
[20] El Argentino, August 6th, 2009.
[21] Figures fournished by the Secretary of Energy in the Balance Energetico Nacional 2007. Concerning the consumption of primary energy, the shares are 23% for the residential sector, 7% for the public and commercial sector, 23% for the transport, 6% for the agriculture and 35% for the industry.

c. The issue of fossil fuels

In Argentina, the energy sector is dominated by fossil fuels. 90,1% of the country's energy consumption comes both from natural gas and oil. The industry sector and the households currently depend on natural gas, as all the infrastructures are built for its consumption. If gas transportation has been an real issue for the long time, all the infrastructures were developed after the privatizacion for the intense use of gas, resulting in the current demand which is more than significant. Today, the main issue results to be the one of the resources.

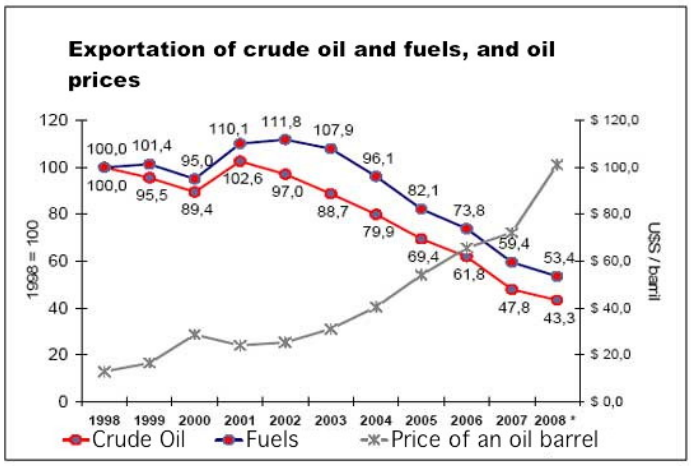




Estimation 2007 by G&G Energy Consultants

The country's natural gas consumption reaches 49% of its total energy consumption. That makes Argentina the third gas consumer in the world in terms of proportion, just after Russia and Netherlands. In the case of Netherlands, it is one of the main countries of gas transit, either liquefied or not, and thus, its occurrence in the head of the list does not seem astonishing. Therefore, we can consider that **Russia and Argentina are the biggest consumers of gas in the world**. Indeed, about 54% of Russia's primary energy consumption comes from natural gas[22]. Nevertheless, Russia has the advantage of possessing 32% of world proven natural gas reserves (23% of the probable reserves) that correspond to 75 years of its consumption. In comparison, **the current proven gas reserves in Argentina should be exhausted in 7,5 years, a delay that is 10 times lower**.

[22] Figures fournished by the International Agency of Energy.



Source : Instituto para el Desarrollo Social Argentino (IDESA)

Since 2004, the gas reserves droped by 50% and the oil reserves drop by 16%. As concerns the oil sector, since 1998 its production is falling whereas the new deposits discovered are not sufficient to sustain the consumption. **Taking into account the fact that the demand remains high, Argentina is becoming more and more dependent on importations and therefore, loses its self-sufficiency**. Indeed, Argentina has reduced its exportations of oil at the precise moment when the prices were raising : a significant part of its oil reserves was sold at a low price during the 90's and the country is now finding itself with a definitive loss, inevitable consequence of a paradoxical economy. **The country sold more oil when the prices were low, and reduced its sells when the prices raised**. In the last decade, the loss of capital due to the decrease of the production reaches $US 10.000 millions per year, and the loss due to the decrease of the reserves reaches $US 50.000 millons[23]. These losses strongly damaged the sector ; that is why it has to be recovered. In comparison, for the same decade, Brazil has doubled its oil production and has increased its reserves of 80% which correspond to 9 years of the country's consumption and a future income $US 620.000 millons that would be due to the exportations and the saving of importacions.

In respect of natural gas, Brazil does not need to take care of its reserves like Argentina do; indeed, if the natural gas almost supplies half of Argentina's energy consumption, it supplies only 8% of Brazil's energy consumption. Yet, still in the same decade, Brazil has increased its gas reserves of 65% which correspond to $US 680.000 millons, whereas Argentina lost some $US 150.000 millions, wasting its reserves. Brazil's energy policy focuses in strengthening the energy mix and maximazing the mobilization of geological resources, in order to improve its energy independance, in an internation context of considerable variation of minerals and hydrocarbons prices.

Inevitably, this waste of reserves leads to an exhaustion in the medium term. Currently the estimations are 7,5 years for gas and 10 years for oil[24]. Thus, the fossil fuels sector has to face two kinds of issues : the first one is the lack of resources and the second one is the high demand.

There is a miss of investments in exploration. The ultimate discoveries of large scale are El Trapial for oil, in 1991, and Loma de la Lata[25] for gas, in 1978, both in the Neuquén province. Until 1999, the drillings for exploration represented an average of 10.5% of all

[23] Alieto Guadagni in El Imparcial, August 26th, 2008.
[24] In comparison, in 1989 the estimations were 32 years of gas reserves and 14 years of oil reserves.
[25] For the Secretary of Energy, this deposit lost 60% of its gas reserves between 2004 and 2008.

the drillings of the sector. From the year 2000, these share fell to 5%, reaching a minimum of 2% in 2002 and 2003[26].

Reserves of oil and gas

Company	Reserves (thousands of m^3)	Percentage
PAE	147,519	36,0%
YPF	84.050	20,0%
Occidental	38.952	9,7%
Petrobras	21.588	5,4%
Tecpetrol	20.362	5,1%
Chevron	19.777	5.0%
Others[1]	68.476	18,8%
Total	*400.724*	*100%*

[1] 35 companies

Company	Reserves (millions of m^3)	Percentage
Total	122,944	30,8%
YPF	68.699	17,2%
PAE	66.704	16,7%
Petrobras	32.042	8,0%
Pluspetrol	25.946	6,5%
Tecpetrol	16.565	4,2%
Others[1]	65.629	16,6%
Total	*398.529*	*100%*

Source : Secretary of Energy, 2008

The geology is also an issue : in the beginning of the 60s, 71 millions cubic meters of oil were discovered for 100 exploration drillings, in 2004, these 100 exploration drillings only brought 8 millions cubic meters of oil. The offshore is seen as an opportunity because there was not much exploration in the seabed and therefore, the chances to discover a deposit of large scale are higher. Still, only the big companies can invest offshore, and YPF, Petrobras, Total, PAE, Wintershall, Sipetrol and Enarsa are investing. Nevertheless, 6 drillings realized in the South Atlantic did not lead to great discoveries. Since the crisis of 2001, instead of investing more in the exploration, the oil companies have reduced their investments and the state owned companies did not realize any operation but only focused in supporting the private ones as shareholders in the authorized concessions. The private companies argued that the governmental policies prevented them from investing because of the control of the internal prices, the retentions, the cutoff values for exports, and the limitation of prices.

To resume, since the privatization, the State lost its ownership of the resources, the private companies being able to invest in the exploitation of the existing deposits[27] instead of investing in exploration to find new ones. This explains the fall of the reserves. **The lack of reserves could lead to cost much more than the investments necessary to recover them[28], because since they are running out and the deposits are stoping their production, the oil equipments are abandonned and the contracts due to end. Thus, the policies should focus in stimulating the investments in exploration**. A possible solution should be to create new regulations for exportation or subsidies that would require the companies to invest in exploration. An incentive law for exploration, that allowed tax reductions for the companies that commited to join Enarsa to invest, was proposed ;

[26] iECO, August 2d of 2009. During the 2000-2009 decade, there were, in average, only 39 drillings of exploration per year.

[27] The investments concerned the technologies of secondary and tertiary recovery ; they allow raising the quantity of gas or oil that can be extracted from a single deposit. The best example is Pan American Energy (PAE) which duplicated in the last 4 years the oil reserves of its concession Anticlimal Grande - Cerro Dragón, located between Chubut and Santa Cruz.

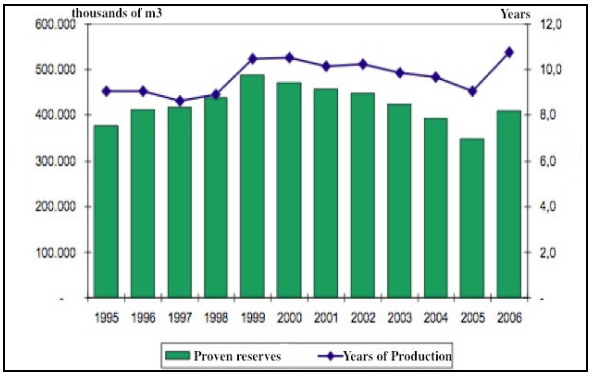
[28] Various studies estimate them between US$500 millones per year without offshore and twice as more counting exploration offshore, which is far more than what the provinces or the companies can actually invest, whether they are private or public (Enarsa).

although it probably went in the right direction, it was a failure. Besides, the market misses clear rules concerning prices or exportation.

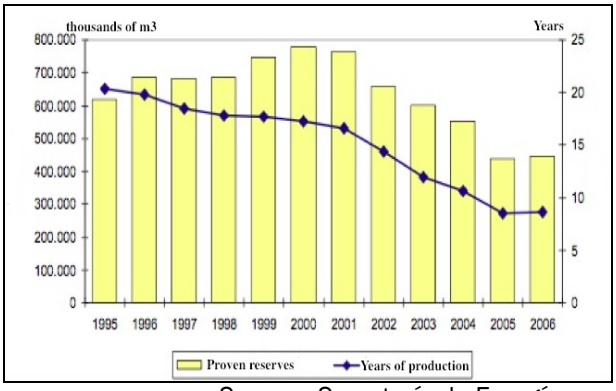
The other end to the issue of hydrocarbons is to follow the example of Brazil, whose policy is **to maintain high prices in order to be able to invest in the exploitation of resources**, with a long term view, whereas the argentinian policy lacks of temporal projection, wasting the accumulated capital as reserves that were abundant before. The price increase seems inevitable anyway, because Argentina will not be able to sustain its loss of self-sufficiency in oil and gas and convert itself into an energy importer.

Proven reserves of oil and gas and years until exhaustion

Gas



Oil



Source : Secretaría de Energía

Regarding the high demand in hydrocarbons, there is a lot of possibilities to reduce it, one of them is using energy more efficiently and another is to diversify the energy mix. In the continuation we will explore options for diversifying the energy mix.

d. The impact of the 2008-2009 world crisis : the current status of the sector

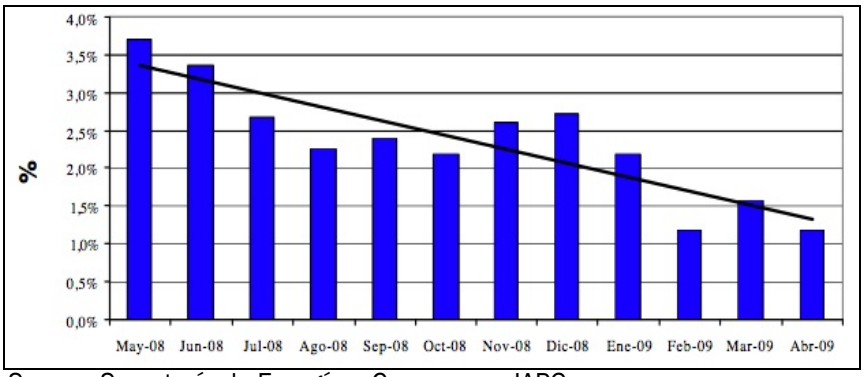
According to the register of national accounts of the INDEC (Instituto Nacional de Estadística y Censos), until the first quarter of 2009, Argentina's economy did not entered into recession : during the third quarter of 2008, it has grown of 7%, during the fourth one, it has grown of 4% and during the first quarter of 2009, it has grown of 2%. Nevertheless, various private estimations reported that the economy started falling in September 2008 and that it entered a strong recession at the end of last year. The

economists Miguel Ángel and Andrea Broda estimate that between the ultimate quarter of last year and the first one of 2009, the economy fell at an annualized rythm of 7% to 10%[29].

In the industry, the official information reports a fall more noteworthy : the EMI (Estimador Mensual Industrial) of the INDEC stalled in November 2008 and fell of 4% in January 2009, but became positive again last june. According to this indicator, during the first seven months of the year, the industrial activity only fell of 1,5% compared to the year before. The indicator of the UIA (Unión Industrial Argentina) reports a fall much more important but this is due to the strong participation of the big companies, heavily impacted by the crisis and the collapse of their exports.

If we observe the energy sector, the interannual variation of the production of oil is negative. The annually accumulated oil production fell of 1,8%[30] and therefore respects the country's tendency with respect to the decrease of oil production for several years. The gas production also fell down, as the decrease of March 2009 reaches 1% with regars to March 2008 and the interannual variation presents a 3% fall of the gas production. Nevertheless, the increase of the electricity demand also slowed down (and therefore there was not any necessity to cut the gas supply for some companies, like it was done last year and the year before). Indeed, the electricity supply of April 2009 was 1,8% less than the one of april 2008 and the accumulated electricity production in one year only increased of 1,2%, which is lower than the previous years. Thus, the global crisis which reduced the economic activity had some advantages concerning the energy supply.

Argentina: Electricity production variation rate over the year in 2008-2009



Source: Secretaría de Energía – Cammesa – IAPG
Elaboration: Departamento Técnico Instituto Argentino de la Energía « General Mosconi »

Electricity

Accumulated Production / *May 2008 – April 2009* (MWh)	110.315.357
Accumulated Production / *May 2007 – April 2008* (MWh)	109.015.138
Variation (%)	1,2%
Internal supply[1] / *April 2009* (MWh)	8.464.700
Internal supply[1] / *April 2008* (MWh)	8.623.269

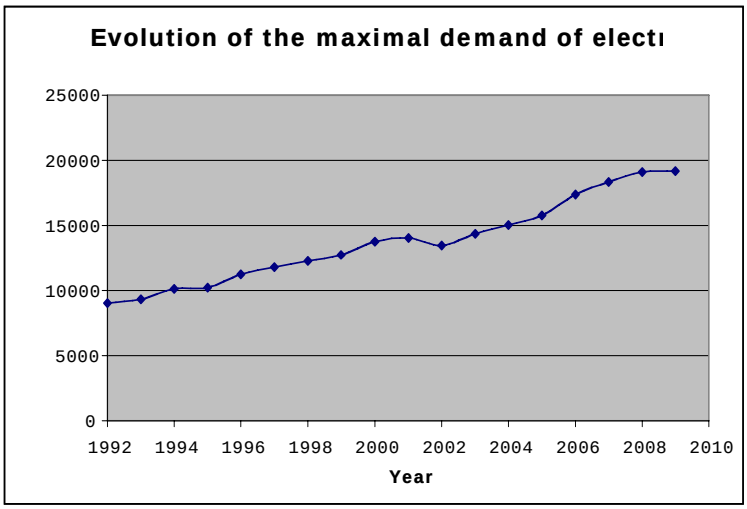
[29] La Nación, Buenos Aires, August 22d, 2009.
[30] Accumulated production of the period April 2008 - March 2009 with regards to the period April 2007 – March 2008 ; figures fournished by the Instituto Argentino del Petróleo y del Gas Natural (IAPG).

Diferencia (%)	-1,8%

[1]Internal supply = Total production + Importations – Exportations

Furthermore, the sales of gas oil also fell down : the sales of April 2009 were 9,4% inferior compared to the sales of April 2008, and the interannual variation presents a decrease of 4,1%. On the contrary, the sales of gasoline have increased: the sales of April 2009 were 7% more than the ones of April 2008, and the average annual sales were also 7% more this year compared to the previous year. Nonetheless, it is still lower than the usual increase of gasoline sales and this deceleration is also due to the reduction of the economic activity.

In this context, we can affirm that even though the crisis generated a decrease of the activity, **today the investments are absolutely necesary for the increase of the energy supply. Today more than before, Argentina should consider the recent decrease of activity as a breath of air which is a chance to make up for the lost time.** Argentina is growing fastly since the end of the national crisis and therefore, the energy demand is increasing every year. Nevertheless, the main investments currently made are the ones necesary for maintening the facilities or conforming them to the quality and safety standards required by the ENRE.



Source : Secretary of Political Economy / Secretary of Federal Planification

The average of the demand's peaks during July 2009 was 4,1% superior as 2008 and 10,8% superior as 2007[31]. Nevertheless, the peak that was reached this year on july 23d (19.566 MWe) is almost the same as the one reached the July 23d, 2008 (19.126 MWe), despite of the that year's lower temperatures[32]. If we compare these figures to the demand of gas, we can see that the global crisis has had more effects on this sector, because it did not grow like the previous years : indeed, the average demand was more or less the same, and the maximal volumes registered (127,6 millions of cubic meters) are a little less than the record registered on July 10th, 2008 (128 millions of cubic meters). In the same way, the gas distributed in the Federal Capital and its metropolitan area (area of major demand) reached 41 millions of cubic meters in 2009, 1 million less than the previous year.

[31] Datas fournished by CNEA

[32] The average temperature of July 2009 was 10,8°C and 14,3°C for July 2008.

Thus, investments are also necesary for the electricity sector, both in the activities of production and distribution, because the country runs an important risk of having multiple power cuts, especially in Buenos Aires and its province. Concerning electricity transport, some serious investments were made these last years, following the Federal Plan of Transport established in 1999 and followed by a second version in 2003 that focused on bringing solutions to the regional systems of electricity transport. Still, we will have the occasion to see that more investments have to be made, with the aim of densifying the grid and increasing the connections with distant areas like Patagonia.

e. Conclusion

Various indicators macro and sectorials indicate that Argentina's economy stopped falling and is currently retrieving itself. According to Andrea Broda, in June-July 2009, the economy stabilized and then started to grow again at a slow rythm (1.5/2,5%). The recovery can be explained by the raise of the demand of exportations, specially from Brazil, but also by the increase of the prices of exportation products. The forecasts for next year are very disparate : in the Project of the 2010 Budget, the governement estimate a 2,5% growth. The private estimations are between 2% to 7% ; these higher figures are due to the fact that the government counts with a lower growth rate in order to have flexibility and to be able to use freely the resources in excess, that would come from the taxation and are neither anticipated nor included in the Budget. The growth is due to recover anyway in the short term, and therefore the energy sector should prepare itself to meet the needs of the country.

The energy sector finds itself in front of several issues that have to be solved at the same time. Mainly, the sector has to be recapitalized, and this is not only a matter of time or trust. The promotion of investments appears to be essential. To this end, the roles of the private and public sector should be defined precisely, and above all, the state should ensure pertinent legislation and real planification for the future. Indeed, the current legislation is not adequate, among others because there is not any legal security that would warrant the maintenance and the stability of a long term strategy for at least 25 years and would be regardless of whether governments change. Thus, the state structures should be rebuilt in order to act on the structural situation and not only according to the economic situation. The second role of the state is to planify the building and managing of power plants, and for this purpose to define precisely the pertinent projects, on the short and on the long term, with the elaboration of a clear frame of the upcoming financial resources before entering the licitation phase.

Regarding policies, the issue of social tariffs has to be thought again, as well as some policies that promote the exploration of new deposits have to be implemented. Furthermore, following the world's trend and more particularly the developed countries, Argentina should propose a constraining policiy for an efficient use of energy, which would be consistent with the raise of the tariffs.

However and above all, the energy mix has to be diversified, to allow Argentina to be less dependent of hydrocarbons. Therefore it is important to study the current development of the various sources of alternative energies in the country, and also their advantages and disadvantages.

2. Alternative energies : not only a political choice, but a necesity

a. Nuclear Energy

Nuclear energy provides an average of 6% of the country's electricity. Its development started in the 50s, after the creation of the Comision Nacional de Energia Atomica (CNEA) whose aim was to coordinate the activity concerning the research and the construction of several prototypes of reactors.

Argentina was the first country in Latin America to build and use a nuclear power station. It entered commercial operation in 1974. The plant – Atucha 1 – is located in the region of Buenos Aires and its installed capacity is of 357 MWe. The second nuclear power plant, located in Embalse Río Tercero, entered commercial operation in 1984 and its installed capacity is of 749 MWe. In july 1981 started the construction of a third power plant, Atucha-2 which would produce a power of 692 MWe but was never achieved, because of the lack of funds and also because of the government's policy that wanted to give up nuclear energy in Argentina. Indeed, if the two power plants represented 15% of the electricty production from 1984 to 1991, nuclear power has declined since then as it is not the case anymore.

In the recent years, a special cooperation between CNEA and the state-owned company Investigacion Aplicada (INVAP SE[33]) gave birth to a new entirely designed nuclear power plant of fourth generation, CAREM (Central Argentina de Elementos Modulares), which is a 27 MWe (or up to 100 MWe) power station of inherent safety characteristics that needs simple operation and maintenance, and could be deployed within a decade. It is apt for application in small cities up to 100, 000 inhabitants. Furthermore, with minor engineering changes, a model of 300 MWe could also be developed and could be an opportunity to export this type of techology to foreign countries, as it was the case for other types of experimental reactors designed by INVAP, that were exported in countries such as Peru, Algeria, Egypt and Australia. Nevertheless, the construction of a first CAREM prototype in Argentina remains a pending issue to the nation : although it should officially start at the end of 2009, it is taking more and more delay. According to some experts, the construction should not start before 2 or 3 years and could even wait for 5 years.

Since 2003 efforts have been made to reform and develop a renewed nuclear energy policy, following the moves of a certain number of developed countries that are developing nuclear energy furthermore, aiming at the reduction of greenhouse gases emissions (nuclear energy practically does not emit any) and the reduction of the dependancy to the hydrocarbons. Indeed these last years have begun constructions of several new power plants in countries such as Russia, Japan, India, South Corea, Pakistan, China, Finland or France. Concerning Argentina, these efforts were concretised in August 2006, when a major advance was made. The governement announced a US$ 3,5 billion strategic plan for the country's nuclear sector, which involved :

- The achievement of Atucha-2 by 2010 (cost : US$ 596 millions).

[33] INVAP SE is a public research company in engineering development.

- The life extension of the two operating power plants
- The construction of a fourth powerplant that would start after 2010. A feasability study has been made and in July 2007, and Nuclearelectrica Argentina SA (NASA)[34] signed an agreement with Atomic Energy of Canada Ltd (AECL)[35] that could lead to establish a project for the construction of one, and possibly two 750 MWe reactors. A government decision on this project is still expected, but the construction should start right after the finishing of Atucha-2. The two units should respectively start in 2015 and 2016.
- Encourage the building of a prototype of the CAREM reactor.
- Support the country in its way of reaching self-suficiency in provisioning of combustible.

The uranium resources

The listed resources currently reach 15,000 tons of uranium, which represent the resources that are necessary to operate 4 power plants during their 60 years lifetime period. Moreover the CNEA estimates that there would be about 55,000 tons that could be discovered following the exploration targets. Thus, **Argentina can consider itself quite safe concerning any lack of uranium resources**, although it needs certain rules to avoid wasting or exporting too much of them. Nevertheless, the mining activity, which started in the mid 50s, has slow down and most of the mines were closed because of economic reasons. In 2007, following the 2006 plan, CNEA reached an agreement with the provincial government of Salta to reopen the Don Otto uranium mine, which operated from 1963 to 1981.

On a worldwide scale, according to most of the experts, a lack of uranium would not happen before the next century and probably before a lot more time, taking in account the fact that the three world's leading countries in nuclear energy (USA, Japan, France) are currently developing the next generation of power plants whose aim is to be able to use combustible several times and even to make combustible from the nuclear waste. Moreover, the political regimes of the countries that would concentrate most of the world's uranium resource (Canada, Australia, Kazakhstan, Russia, Niger, Namibia) are said to be stable, and therefore, the uranium world's supply can be considered much safer than the issue of oil supply, which involved wars and dictatorships.

With regard to the enrichment, it is currently imported from the USA, although from 1983 to 1989, INVAP operated a small enrichment plant for CNEA at Pilcaniyeu, that was closed because it did not produce enough uranium and furthermore, it did not enrich it enough. But in August 2006, CNEA wanted to recommission the plant using its own technology of enrichment, which is said to be competitive. It was proposed to restart and increase the production in 3 years, to reach an enrichment capacity that would allow Argentina to export enriched uranium instead of importing it, as importing enriched uranium does not assure the country's independancy and maturity in the use of energies that are alternatives to hydrocarbons. **If Argentina is due to continue and develop nuclear energy, it seems important that it should have the competences to control the whole nuclear cycle, from the extraction of uranium to the nuclear waste management**.

[34] NASA is the public company who took in charge in 1994 the operation of the nuclear power plants in activity (Atucha-1 and Embalse).

[35] AECL is the canadian nuclear company that cooperates with Argentina since the Embalse project, and currently works at extending the life of the power plant.

Nuclear waste management

Argentina still does not have any policy of nuclear waste management on the long term. Spent fuel is currently stored at each power plant. In 1985, a project of in depth storage was started and the locality of Gastre (Sierra del Medio) was chosen to store 75 cubic meters of high level waste for at least 10.000 years. Due to the protests of the local population, the project was cancelled by the CNEA in 1997, after a status quo which lasted 12 years. Nonetheless, **if Argentina wants to build new power plants, it appears essential finding a solution concerning the treatment of the waste**, not only because their volume will increase, but also because the national and local populations would accept a power plant project more easily.

All the countries that does have a nuclear waste management policy chose the in depth geological storage, or are in the process of choosing it. But if we take a closer look to their policies, we can separate two kinds of policies : those of the big countries that possess a large amount of nuclear power plants and made the choice of treating their waste before storing it (France, USA, Japan), and those of smaller countries that only possess several power plants and decided to store their own waste without treating it (Finland, Sweden). Each policy has its advantages and disadvantages. Nevertheless, in our opinion, **the examples of the northern Europe's countries could be easily applied in Argentina**, although a stable and rather calm political climate seems necessary. Indeed, the scale of the nuclear industry in Argentina involves a small volume of nuclear waste, and therefore, it does not seem relevant to develop the technologies for its treatment, to form engineers or to build facilites, as it would not be profitable : the small amount of waste can be burried directly and there is no necessity of recovering fresh combustible from it.

The success of the swedish-finish model can be explained in three key factors that could inspire Argentina if it were to develop a nuclear waste management policy :

- First, the countries were already storing their low and medium level waste in the underground within the geological depth, without retreating it. Therefore, they had a first experience for the storage of nuclear waste, which is not the case of the countries that are retreating[36] their waste and did not make any previous attempts of in depth storage.
- These countries also had the idea of separating the site where scientific studies were conduced from the future site in which the waste would really be stored, and therefore, the acceptability by the population has been easier. Indeed, on one hand it allowed to multiply the number of municipalities that proposed themselves as sites which could be chosen for the construction of the laboratory. On the other hand, the in depth laboratory was created with the support of the local population only because the law specified that the laboratory would never be transformed in a real storage site. In other terms, the laboratory could be built because it was certain that it would not be the site of definitive storage. The transparent studies that were conduced by this laboratory allowed the population to accept more easily the idea of an in depth and definitive storage. We can also notice that separation between the laboratory and the storage site does not implicate the fact

[36] The retreatment reduces the volume of the waste, separating radioactive elements from clean ones, as well as it allows to extract fresh combustible from it. The low and medium level waste can be stored above the ground waiting for their release in the environment, but the high level waste have to be burried, as they cannot be supervised undefinitely.

that the storage site has to be located far from the laboratory. Indeed, one of the two probable sites in Finland is located at a distance of only 7 km from the laboratory.

- The success of the swedish-finish model is also due to their political climate, which is rather calm and stable and allowed to establish some serious public debate, on topics as sensible as the nuclear waste management, without having to deal with a large amount of protests from every part.

The overcosts

If the costs of the nuclear waste management were implemented in the price of the kWh, nuclear energy will be much more expensive. Furthermore, the price would also have to be increased to cover the cost of the dismantling of power plants. Indeed, after several decade of operation, the power plants have to be shut down, but all the plant's components, specially in the reactor, remain contaminants. In the occidental countries, two major debates take place around this issue. The first one is the choice beteween a rapid dismantling, which would start directly after the plant's shutdown (USA, France), or a delayed dismantling that would take place about 25 years after (Spain, United Kingdom), its advantage being to be shorter and less expensive, and to produce less nuclear waste. According to an inquiry of the OECD (Organisation for Economic Co-operation and Development) of 2003, 21 of the 42 companies that were consulted prefer a precoce dismantling, whereas the other 21 prefer a delayed dismantling.

The second debate concerns the cost of the dismantling. In 2000, the french operator EdF estimated it at $US 203 millions for a single reactor, whereas the OECD estimation was of $US 288 millions. Today, the estimations vary between US$ 500 and 800 millions, sometimes even one billion. The estimations increase regularly as the experts realize little by little that there is a lack of experience and that the techniques are not fully developed[37]. The International Atomic Energy Agency (IAEA) estimated recently that $US 500 billions would be necesary to dismantle all the nuclear industry currently in place in the world : there are 440 reactors to dismantle within 30 years[38]. In order to cover the cost of the dismantling, some operators have created specific funds, whose resources are constituted by a surcharge in the price of the kWh[39]. For example, since 1979, EdF has constituted a fund of $US 11,6 billions. But the reserves for the dismantling were under-evaluated. Indeed, 70% of the reserves destinated to the dismantling of the french power plant *Saint-Laurent A* have already been consumed while its dismantling has just entered the very beginning of its second phase (out of three).

In Argentina, there is not any policy concerning the surcharges generated by the dismantling, nor by the nuclear industry in general. But **these costs should have to be taken into account** if the State has to decide whether it is more profitable to start the construction of a new nuclear power plant or to stimulate the development of renewable energies.

A policy of very long term

[37] About 10 reactors have been totally dismantled in the world.
[38] Le Monde, October 2d, 2008.
[39] In France, this surcharge was evaluated in 1995 at 5% of the price of the kWh, but is currently reevaluated.

In conclusion, one can notice that an implemented nuclear industry would indeed be advisable for Argentina. It already possesses the competences for the building and the management of a nuclear power station, a past experience in mining and enrichment. But as the entire nuclear cycle has to be managed, we think that **the country will have difficulties to access, in the medium term, the nuclear energy strength necessary to avoid the troubles caused by the exhaustion of hydrocarbons**. Indeed, it needs high public investments which would have to be helped by private funds. Moreover, the experiences of the countries that are currently restarting their nuclear industry show that the estimated costs for the construction of new powerplants, already high at the very beginning[40], were wrong estimations and for instance, the Finish project which was supposed to be achieved in 2009, is today more than 75% over-budget[41], suffers from a 3 years delay and all indicates that this delay will be extended. Currently there are only 4 european reactors in construction ; due to the Finish experience, the ones that were supposed to be contracted soon are now called into question. Therefore, investing in new nuclear reactors means taking a certain risk, that the State should take into consideration because the private investors will not take it, especially if they are aware of the previous experience of Atucha-2 ; moreover, the project is already taking delay, as Atucha-2 should open around july 2011 instead of 2010.

As for the CAREM project, it is still at a stage of a prototype that is not even built yet[42], and therefore, it can also be considered as a project of very long term and will not have any industrial applications in the 10 next years. Nevertheless, **Argentina should encourage its development which could lead to a great success and a significant role in the country's production of electricity in the future. More generally, Argentina should support the research in new nuclear technologies that could be more efficient and less polluting**.

The last pending issue concerning a nuclear energy policy is **to compare it to other alternative energy policies, as for the resources, costs, competences, technology and attractivity**. One can suppose that if Argentina decides to launch herself in the building of new nuclear power plants, it may compromise other alternative projects that could produce more benefits. We will have the occasion to discover this in the following parts. Therefore, concerning nuclear energy, **Argentina should focus itself in extending the lifetime of the two existing plants and achieving Atucha-2**.

b. Hydroelectricity

The theoretical hydro potential of the country is estimated at 169.000 GWh/year whereas the technically feasible potential reaches 130.000 GWh/year. Nevertheless, only 25% of it has been developed yet, and represents a capacity of almost 10.000 MW. Currently there are 13 units that are national concessions containing between one and three power plants and operated by private producers, either national or foreigners. Yacyretá and

[40] The *initial* cost estimated for the European Pressurized Reactor (EPR) were about 4,3 billions US$ for a 1650 MWe of electricity generation.

[41] Involving an overcost of more than 3,3 billions US$ which raised the total cost of the power station at 7,6 billions US$.

[42] Even if the first prototype was originally scheduled for 2010, according to some experts its construction should not start before several years.

Salto Grande are bi-national projects (with Parguay and Uruguay), and are not concessionned. In total, about 66% of the capacity is privately owned[43].

In 1990, hydroelectricity fournished 50% of the country's electricity, but its share has been reduced at 28,53%[44] today (33% in 2008). The Government is in charge of identifying new projects and realize technical pre-feasability studies and the private sector is in charge of realizing feasability studies and implementing new projects, with the agreement of the Government through a licence, whose role is to regulate the project as regards its integration with other central grid supplies or the alternative water use. The aim of these licences is also to manage dam safety and environmental control in the areas of hydroelectricity production. In 2008, the Secretary of Energy identified 12 projects of major interest in a list of 30 probable projects whose total capacity reaches 8.169 MWe. At the same time, an estimation of the construction costs for hydropower plants was elaborated.

National projects

New hydropower plants projects

Power Plant	Capacity (MW)	Status
Los Caracoles	125	In operation
Chihuidos I	637	Process of awarding
La Barrancosa	600	Process of awarding
Cóndor Cliff	1.140	Process of awarding
Chihuidos II	228	Licitation
Portezuelo de Viento	90	Licitation
Los Blancos	443	Licitation

Source : MEM

In June 2009 was inaugurated the Caracoles plant on the San Juan river. With a capacity of 125 MWe and 715 GWh of annual generation, it will hopefully bring 40% of the provincial consumption. At the end of July 2009, 4 groups made some offers for the building of the Chihuidos I plant on the Neuquén river. The project will produce 1.750 GWh from a capacity of 637MWe, and represents an investments of US$ 1.100 millions. The projects of Chihuidos II and Los Blancos are also currently analyzed. Los Blancos, on the Tunuyán river (Mendoza) represents a US$ 700 millions investment and should enter in operation in 2012. In Santa Cruz, the projects of La Barrancosa and Cóndor Cliff will generate some 1.700 MWe and are in the process of being evaluated, the investment being estimated at US$ 1.000 millions.

International projects

In the same way, the brazilian company Electrobrás announced an investment of US$ 3.000 millions for the binational Garabí plant whose capacity should be of 2900 MWe. The project is still at the stage of study but was concretized by the agreement reached in February 2009 between Argentina and Brazil. The government is also planning to raise up the high of Yacyretá at 83 meters, raising its capacity from 1.700 to 3.100 MWe. But the

[43] Hydrolelectric power and development in Argentina, Gustavo Alberto Devoto, ENRE.
[44] Accumulated production of 2009 in July, CNEA.

issue of the rehousing of the Paraguayan households enlightens the difficulty of achieving the project.

A lack of planification

Nevertheless, these projects are specific projects. They are not part of any plan of investments : in Chihuidos or in Santa Cruz, the government will not invest any money as long as the private investors do not invest 30% of the calculated amount that is necesary for the project. Therefore, it leads to a vicious cycle in which the private investors do not invest because they would take the risk that the government would not find money to complete their investment. That is why **it is absolutely necesary to develop a plan of investments** that would be based on the 70s and 80s model : the government could borrow some 30% of the project to the Interamerican Bank of Development (BID[45]) or to the World Bank (WB), and refunds its loan with specific funds constituted by overcoasts payed by consumers. But today, **consumers are not ready to pay more for their energy, the recent example of gas prices shows how difficult it is to impose a raise of prices, specifically in a context of economic crisis** ; and moreover, the government does not seem to change its positions concerning its investments in hydropower plans.

Still, another main barrier concerning hydropower plants projects remains the social context, as for a significant part of the population, specially in the coastal areas, it is deteriorating the environment. Furthermore, the high voltage line that links Patagonia to the North of the country currently supports 500 kV. **The capacities of electricity transportation from the South to the North being limited, the building of new means of production for the SADI should not be over-estimated**[46], with regard to the necessity to create other high voltage lines.

In conclusion, **the development of hydroelectricity founds itself in front of institutionnal, structural and social barriers that slow down the achievments of many projects and cannot ensure a reliable growth of the supply, both on the short and the long term. But the main issue remains the way to finance these large structures, because there is a high uncertainty about their profitability.**

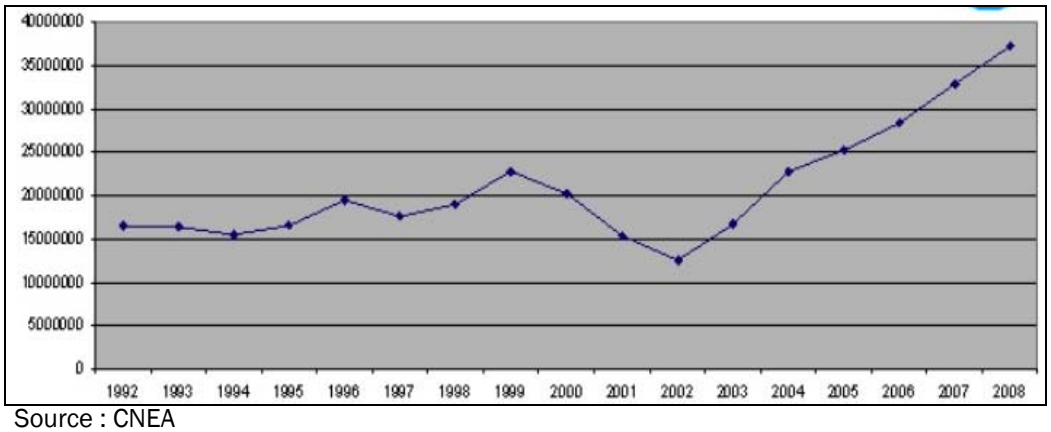
c. Advantages and disadvantages of renewable energies

Therefore, we should focus on the renewable energies, that could be part of a solution to the issue of Argentina's energy independence. The use of renewable energies offers advantages and disadvantages. It is convenient to analyze what would they be, in the aim of finding what would be the benefits for Argentina, if the country starts to develop this source of energy on a large scale.

Tons of CO_2 emited per year by the electricity sector in Argentina

[45] Banco Interamericano de Desarrollo.

[46] All the more if we take into acount the wind energy projects that are part of the governmental plan for the use of renewable energies.



Source : CNEA

The advantages of renewable energy is that it is inexhaustible, as well as it does not pollute the environment. Today, 66,5% of the world's greenhouse gases emissions are due to the energy sector[47]. Moreover, it is of free access and its use can be variable, in other terms it leaves the choice for the operator to use it for the necessity of every moment (the nuclear generation of energy, for example, cannot be turned on and off instantaneously).

Nevertheless, the main disadvantages is the localization of the resources, that induces a territorial limit for their use, because in some parts of the country it would not be profitable; indeed, the sites have to be chosen very precisely, analyzing the quantity of renewable source available in the region. The second disadvantage is that even in the regions in which facilities can be implemented, the renewable source, either wind or sun, is intermittent and random. Nevertheless, its variable distribution is often said to be an advantage, because it allows to reduce the risk of intermittency ; both distribution and intermittency allow renewable energies to be a good complement of other types of energies. Furthemore, the intermittency of all forms of renewable energies enlightens the idea of a development of various renewable sources, as they can supplement themselves, and therefore create a relevant renewable energy mix.

To resume, deciding whether a country should start developing renewable energy on a large scale depends of its resources in terms of exposed territories. On the economical point of view, even if the original investments for the installation of the facilities that produce energy are often higher for renewable energies than for diesel systems, the costs of the equipment's maintenance are lower, there is no need of combustible supply, and lastly, their lifetimes are longer. The resulting industrial and social development should also be taken into account, as well as the fact that less negative externalities are induced.

At the territorial level, the use of renewable energy can lead to two major improvements :

- Improve the electricity supply, and therefore life conditions, for rural regions of low population, increasing the provisioning of private houses and public infrastructures (lightning, for example), but also used as a complement for the small equipments that producte electricity from gas oil and work only several hours per day, due to economical reasons.

[47] Figure fournished in 2005 by the World Resources Institute, Climate Analysis Indicator Tool (CAIT). In Argentina, because the agricultural sector also emits a lot, this part is lower, but still high : about 60%.

- In the regions linked to the SADI, if they possess sufficient renewable sources, it could be possible to implement power stations that could reach high potencial (250 MWe for wind farms, 500 MWe for solar farms). **The electricty generated in these facilities would be directly inserted in the high voltage grid**, and today it seems relevant to study their profitability and their benefits, for Argentina as well as for any other investor.

In conclusion, taking into acount all that was said about the status of the electricity market, the exhaustion of hydrocarbons, and other energy sources, **the question is not whether Argentina should develop renewable energies on a large scale or not, but the election of the relevant sources in terms of social, environmental and economical profit and the means to develop them**. We will see in the continuation how Argentina could develop public policies and incentives for the development of various sources of energy, and what are the relevant renewable sources to be chosen for the country.

d. The current status of renewable energies policies in Argentina

In 2008, 115.750 GWh were generated, but only a little more of 1% is of renewable origin (that is to say all the renewable sources excepting the hydro power plants whose capacity exceeds 30 MWe). **Thus, Argentina is far from reaching the target fixed lastly by the government** :

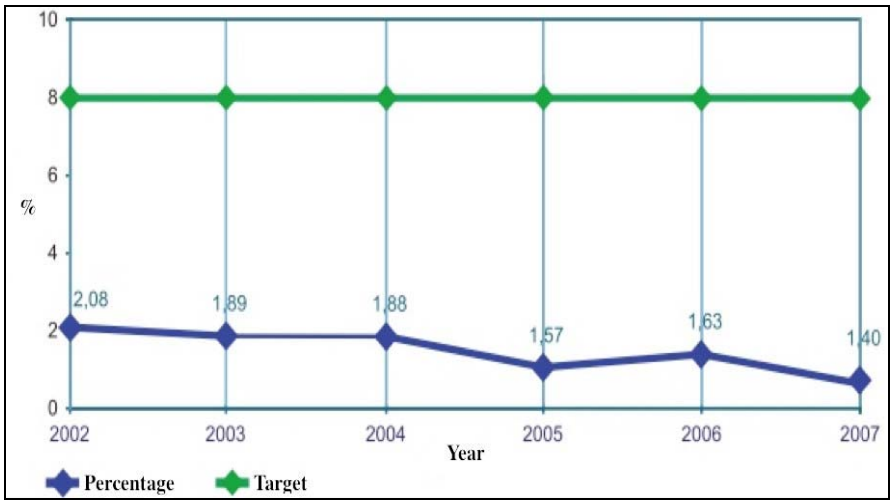
The Ley n°26.190[48]

This law was voted in december 2008 and represents a notable step towards the development of renewable energies, even if its targets are not ambitious enough and the way of achieving them remains obscure :

- **The proportion of renewable energies must reach 8% of the national consumption of electricity in 2016**. All sorts of renewable sources are considered ; with regard to hydrolics, only the facilities whose capacity is under 30 MWe are taken into account.
- **A Federal Program for the development of renewable energies will have to be elaborate** and should take into consideration various aspects of the challenge : technology, production, economics and financings necesary for the administration and the achievement of the target.

Participation of the renewable energies in the electricity generation and governmental target

[48] Boletin Oficial n°31.064, Monday 2d of januar 2007 pp. 1-2. Ley 26.190 « Regimen de fomento nacional para el uso de fuentes renovables de energia destinada a la produccion de energia electrica ».



Source : Unidad para el Desarrollo Energético Sustenable (UDES)

II. CHARACTERISTICS OF A GOVERNMENTAL STRATEGY FOR THE DEVELOPMENT OF RENEWABLE ENERGIES

Introduction

The issue of energy calls answers for the short and long terms. The solutions have to be found in substituating gradually fossil fuels by other resources, and also in restoring, preserving and protecting the environement. The decrease of the industrial activity has been a chance for Argentina, because its means of electricity generation are very limited. It is now the time to planify an increase of the electricity generation capacity, and it seems necesary to develop alternative energies ; indeed, **the renewable energy market in Argentina is very delayed compared to most of the occidental countries, but also with developing countries like China or Brazil**. Today, at least 60 countries apply renewable energy policies detinated to electricity generation, most of them being of national scale[49]. A strategic vision of the development of the energy capacity in Argentina has to consider all kinds of resources and specifically the renewable resources, because the geography of the country promises many possibilities and therefore a high potential, both in wind and solar.

Three years ago was anounced a National Strategic Plan for the Wind Energy, but it has been paralized until today, and there were practically no investments made in the sector. Currently none of the argentinians wind mills manufacturers has entered the series production phase. But Argentina should really increase or develop its alternative energy industry, which is clean and renewable, following the examples of countries that are more advanced, like Germany or USA.

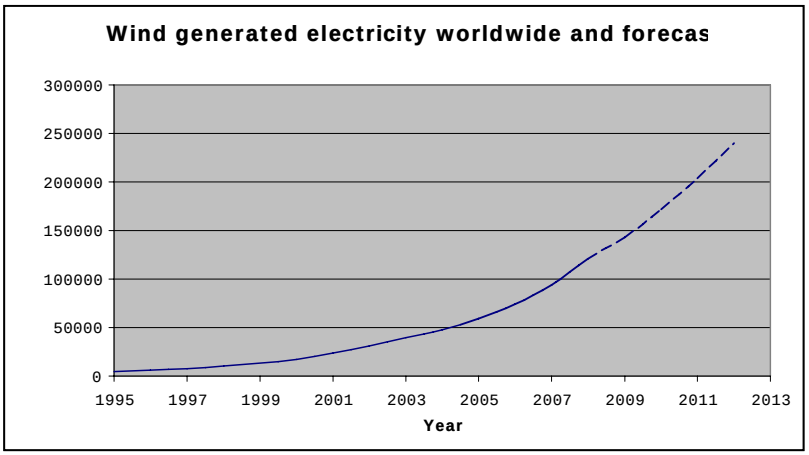
1. The international experience

[49] The USA and Canada are exceptions, as the policies of promotion and support are governed at the level of the States and/or the Provinces.

a. Renewable energy in the frame of environmental treaties

An example : the recent growth of the wind energy

We have seen these last years a significant increase in the use of renewable energy and specifically of the wind resource to produce electricity. Indeed, if in 1998, the wind capacities worldwide were about 10.200 MWe, they reached last year an amount of 120.791 MWe. Moreover, the listed projects for the next years do not show any slowing in the exponential increase, as the capacity is expected to double by reaching 240.000 MWe in 2012.



Source: The Wind Power.net

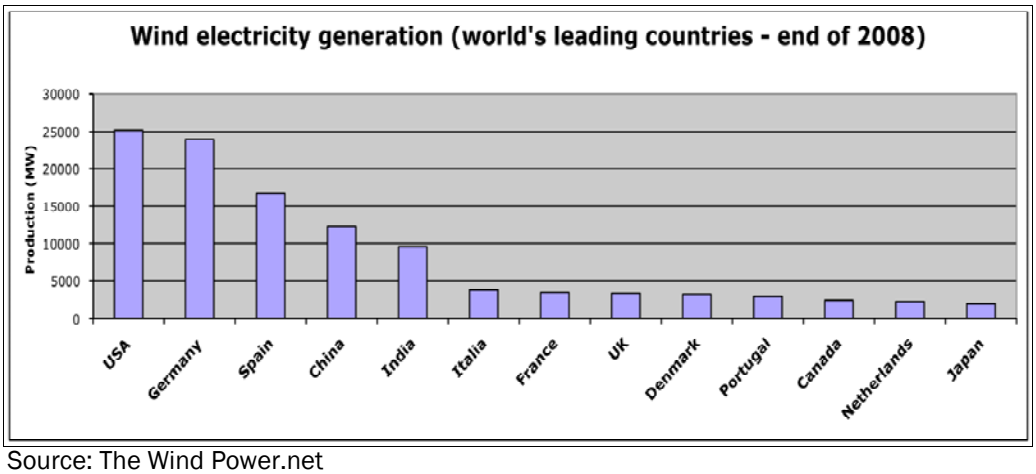
This increase is mainly due to the developed countries, as most of the world's leading countries are the ones which have developed a significant capacity in wind energy. With the notable exception of Russia (which only produced 17 MWe of wind generated electricity at the end of 2008), all the G8 countries have concentrated their efforts in developing and increasing the use of their wind resources. This very recent interest in wind energy (and in renewable energies in general) can be explained by several factors : first, climate change forces developed countries to emit less greenhouse gases. This obligation is not only a moral obligation (developed countries being responsible of most of the world's emissions since the middle of the 19th century), but also a legal constraint, as most of them have signed international and communautarial treaties that require some changes in their energy mix. There is also a will for these countries to be more independant, at least concerning energy, as the price of hydrocarbons, and their availability, are getting more and more insecure. Another reason that could explain the recent development of reneable energies could be the lower costs and the higher profitability. The last reasons could be the advantages of the wind energy in itself, as it does not need any raw material to produce energy, the only energy resource being the wind itself, and therefore, it is an energy « renewable » as there is no potential end to its use ; in other terms, wind energy, and renewable energies in general, are supposed to have an positive impact also on the long term.

The beginning of an international frame

Since the first report of the Intergovernmental Panel on Climate Change (IPCC) in 1990, the governments of occidental countries have becomed aware of the effects of human activities on global warming. In 1992 was established the first conference of the UN on

this topic, which gave birth to the United Nations Framework Convention on Climate Change (UNFCCC). Since then, the head of states that are part of this Convention meet each other every year.

Around the mid 90s, new measures seemed necessary. That led to the most important international treaty dealing with climate change : the Kyoto Protocol which requires, among other things, a decrease of 5,2% of greenhouse gases emissions for 2012, with regard to their level in 1990, for 37 industrialized countries (listed in the Annex I of the treaty). This treaty presented the first constraining objective in the fight against global warming. The European Union (UE) ratified it in 2002[50], although all its members had ratified it before.



Source: The Wind Power.net

Renewable energies in the European Union

In 1997, the European Commission published a report on the renewable energies, in which it expresses **its intention of doubling the share of UE's renewable energies, to reach 12% in 2010, with the aim of responding to 3 main issues : the fight against global warming, UE's energy security, and the promotion of competitivity and technological innovation**. Moreover, the report pointed the necessity of developing all the renewable sources and improve the access to the electricity grid for these energies.

The report has been followed by 2 european directives that concretised these objectives of promoting renewable energies. They proposed indications of targets for each member State, to realize before 2010. Furthermore, they established measures to improve the growth and the access to renewable energies.

The directive of 2001 (2001/2007/CE)

In the first place, the directive required that the European Commission publishes every two years a report that evaluates the progresses of the member States in the realization of their objectives concerning renewable energies. Furthermore, it required that measures were taken to improve the information of the consumers, as issues that have not to do with the costs should not limit the growth of the renewable electricity :

- The establishment of « garanties of origin », that attach a label to the production by renewable or by cogeneration. Nevertheless, they have not been established

[50] Argentina ratified it september of 2001.

in every member State yet, and raise problems of reliability, as well as double accounting. The transfers of garanties between member States are autorized, so that each one can achieve its objective at a small cost, but actually not a single transfer has been made.

- The simplification of the administrative procedures for the planification and the development of renewable energies. But the progress that has been made is not considered enough, as inquires show that the waiting times and the uncertainties following these procedures remain significant, slowing down this development.
- The improvement of the access to the electricity grid, which presented several aspects : adminisrative (the human resources were not sufficient enough to deal with the treatments of the demands) and tecnical (renewable energy being more variable, that limited the capacity of connecting it to the existing grid), but also financial, with various tariffings that often are doubtful, and can privilege big and ancient producers, in front of smaller ones.

The directive of 2003 (2003/30/CE), called « biofuels »

This directive required that the member States impose some objectives concerning the share of renewable energies that replace the fuel and diesel, with a minimum share of 2% in 2005 and 5,75% and 2010.

This directive points also several aims : to improve the security in the provisionning, decreasing the use of fossil fuels and diversifying the consumption, to create more jobs, to reduce greenhouse gases emissions, and at last to contribute to the intensification of the agricultural production in the EU, the decrease of the speed of the abandonment of the fields have positive effects on the erosion, the prevention of fires and the preservation of landscape.

The directive of 2009

In 2005, the European Commission proposed an action plan in the field of the biomass and published a report in 2007, as well as a roadmap for the sources of renewable energies. These reports point the slowness of the progress of renewable energies (except for wind energy, see table that follows), and the fact that the objectives for 2010 will not be achieved on time. **That can be explained by the fact that the objectives were just indications and not a legal constraint. Moreover, the uncertainty concerning the legal frame did not encourage investments.**

These slowness led to the adoption of a new directive (« Directive 2009/28/EC of the European Parliament and of the Council of 23 april 2009 on the promotion of the use of energy from renewable sources ») which is the most significant step into a legal constraint of the european law on the renewable energies.

In the beginning, it is said that it establishes a common framework for the promotion of renewable energies, which implicates to fix targets concerning the global share of the renewable energy in the final raw consumption, and in particular, its share in the field of transports.

New power capacity installed in 2007 by fuel in EU-27 (MW)

Source	MW	% of total

Natural Gas	10.670	50.2%
Wind	***8.554***	***40.3%***
Nuclear	987	4.6%
Coal	332	1.6%
Fuel Oil	212	1.0%
Biomass	196	0.9%
Large Hydro	175	0.8%
Other	122	0.6%
Total	21.245	

Source: Platts PowerVision and EWEA, january 2008

Then it defines the action plan, which is that « each member State shall adopt a national renewable energy action plan » and « Member States shall notify their national renewable energy action plan to the Commission by the 30th of june, 2010 ». Concerning the targets, it is said that « such mandatory national overall targets are consistent with **a target of at least a 20% share of energy from renewable sources in the Community's gross final consumption of energy in 2020**. In order to achieve the targets (…) each member State shall promote and encourage energy efficiency and energy saving ».

In other terms**, the European law leaves to the States the freedom of choice concerning the policies of promotion, as well as their own responsability to reach a global and constraining target**. Afterwards, the directive clarify the way of calculating the share of renewable energies, as well as the possibility to process energy transfers from one State to another, the framework and the conditions of the projects leaded by several member States, and the possibility of making transfers from a non-European State.

To achieve the global target, the European Commission has fixed national targets for each country, taking into account its current share of renewable energy but also its size and its level of development.

European Commission's national targets for some of the 25 members

	Share of energy from renewable sources in gross final consumption of energy, 2005 (S_{2005}).	Target for share of energy from renewable sources in gross final consumption of energy, 2020 (S_{2020})
Germany	5.8%	18%
Spain	8.7%	20%
France	10.3%	23%
Italy	5.2%	17%
Austria	23.3%	34%
Portugal	20.5%	31%
Sweden	39.8%	49%
United Kingdom	1.3%	15%
Hungary	4.3%	13%

Source: European Commission, Directive 2009/28/EC

As an indicative trajectory, the European Commission proposes the Member States to follow some baselines of stronger growth every two years.

The first report of the European Commission is expected for 2012, and then it shall publish other reports every two years until 2021. The frame of analysis for the Commission is separated in 5 points : the environmental benefits, the economical impact of the growth of biofuels, the conservation of biodiversity, the development of biomass,

the tecnical and scientific improvements of all the way to produce energy from renewable sources.

b. The different incentives for investments in various countries

To conform to the international treaties and directives, a lot of developed countries have applied incentives on the national scale to promote renewable energies, the first aim being the development of the technologies, because each improvement leads to a decrease of the costs and makes renewable energies more competitive. These incentives were also proposed in order to reduce greenhouse gases emissions and diversify the energy mix, making these countries less dependant of hydrocarbons. They have stimulated investments and the development of a new industry.

Feed-in tariffs (FIT)

This kind of incentive has been adopted by most of the european countries (for example, Spain and Germany) but also by Brazil, China or Australia. This system guarantees to the producer the payment of a prime which allows him to cover its costs (renewable energy's costs being still higher than the market prices) and ensure him a sufficient profitability. This prime can also be distributed as a fixed tariff received by the producer for a certain period of time.

Generally, a fund is constituted by the financial contribution of all the consumers through specific charges. This fund serves to pay the prime to producers, compensating the differences of costs and turn renewable energy projects into economically viable and sustainable projects. In some countries, like Uruguay, the FIT system has been implemented through long term contracts with the national electricity company.

Obligatory quotas / Direct incentives

This kind of incentive has been adopted by more than 20 States of the USA, Sweden and the United Kingdom, among others. It consists in imposing a minimal volume (or percentage) of renewable energy in the activities of production or selling. If these quotas are not respected, the company has to pay a high penalty.

It is generally implemented through « renewable energy certificates » distributed to the electricity producers according to the amount of electricity they produce from renewable energy (per each MWh). The distributors or the big energy users who have to respect the quotas actually buy these certificates to the generators, directly or through « traders ». The value of these certificates is the difference between the average costs of renewable energy projects and the electricity market price, as long as it does not exceed the amount of the penalty for being out of quotas.

Tax credits

This system is used by the national government of the USA, and other countries. It consists in allowing tax credits on a percentage of the initial investments and/or on the energy generated.

This incentive has been very successful in the USA, considering how the wind energy industry and the solar energy industry have grown during the last 5 years. Currently, the

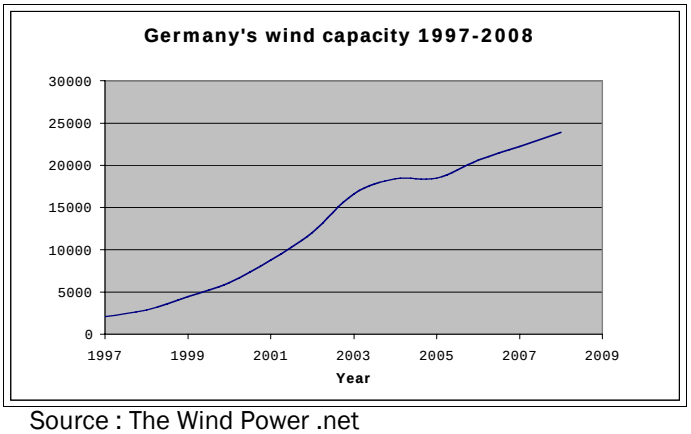
wind energy projects receive a tax credit of US$ 20 for each MWh produced. In some states, both systems of tax credits and obligatory quotas are efficient, and the producers can combine the tax credits they receive selling their energy to the market with the selling of their certificates.

These economical incentives have to be combined with clear operative and technical rules. **In each region should be allowed the possibility to connect and introduce energy to the electricity grid in safe conditions**.

c. The case of Germany

The world leader in wind energy

If we look at the leading countries in wind energy, we can see that wind energy represents a significant share of the electricity production in many countries : 11% in Spain, 20% in Denmark. Moreover, in countries like the USA, 40% of the new generation units installed in 2008 were wind farms. With 23.903 MWe of wind electricity installed by the end of 2008[51], **7% of Germany's electricity consumption comes from the wind resource**. But taking into account the facts that it is the biggest energy producer in Europe and that its limited resources, whether it is the wind velocities or the extent of the territory, regarding the scale of other leaders, and therefore, that it is an exemplary country as for the development of wind energy, lead us to chose to study more deeply the public policies in favor of wind energy in this country, policies that could inspire a future development of wind energy in Argentina.



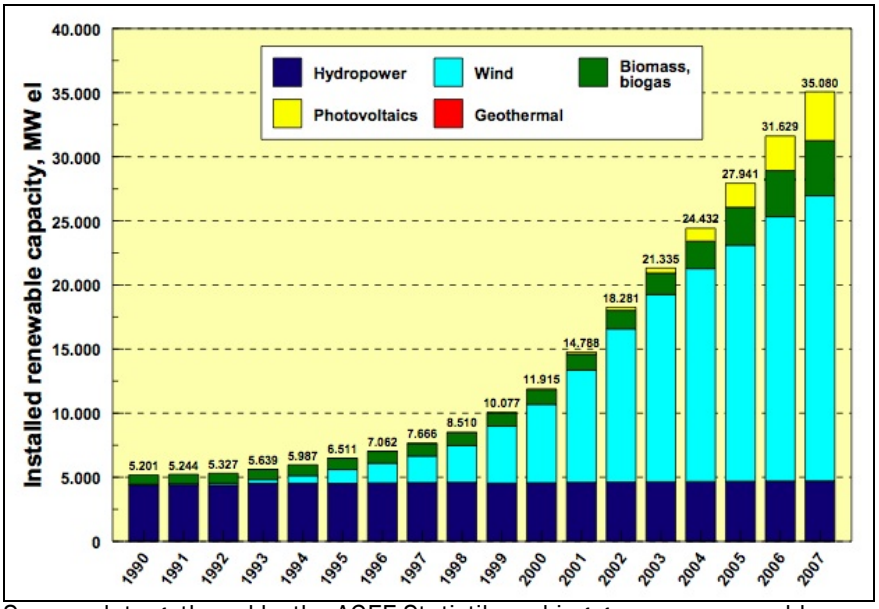
Source : The Wind Power .net

Germany is also a good example of the world's tendency, as its capacities have been mutliplied by a factor 10 in 10 years. Furthermore, it is a European country and we have seen that most of the world's leaders in wind energy are european, and we have seen also how a union of States can implement constraints in its common law, or in its treaties. Still, the States can be more ambitious and have a total freedom for choosing their own policiy to reach their targets. **Germany's national target is to generate 30% of the electricity supply with renewable sources by 2020**[52].

[51] http://www.argentinaeolica.org.ar.

[52] With regards to greenhouse gases emissions, Germany's long term target is a reduction of 20% for 2050 compared to their level of 1990.

Cumulative installed capacity of renewable electricity generation since 1990



Source: data gathered by the AGEE-Statistik working group on renewable energy statistics [BMU 2008a]; [BMWi 2008].

The renewable energy sector in Germany

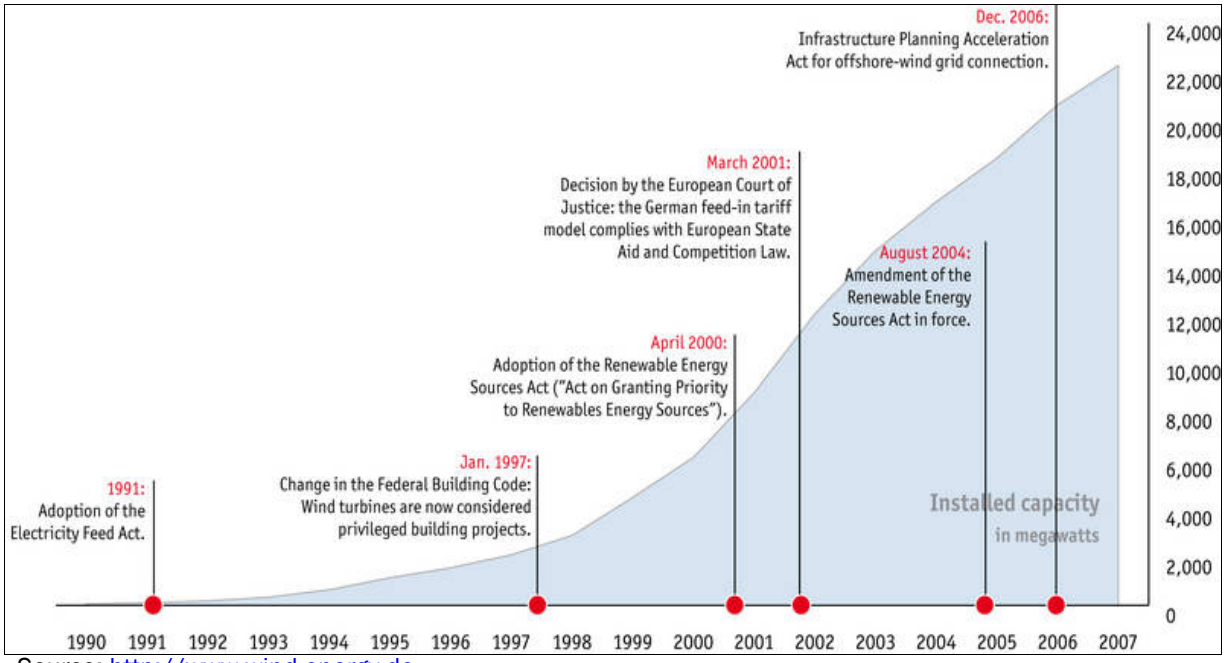
The development of renewable energies in Germany was made in the aim of reaching the benefits of its use : the reduction of the importations leading to be more independent, jobs creation, reduction of greenhouse gases emissions.

The Energy Feed-In Act[53] - 1991

The first incentives were preferential interest rates and subsidies. Soon, the access to the electricity web was improved and guaranteed : since 1991 every producer can access the grid, both big and little producers who use renewable resources. **The renewable energy sector profited the implementation of *feed-in tariffs***, that guaranteed a determined remuneration for a fixed period of time and for each kWh sold to the electricity transport companies. These companies being moreover legally obliged to buy all the electricity supplied by the renewable energy producers. Nevertheless, the tariffs were insufficient for a significant development of most of the renewable sources, with the notable exception of the wind sector which easily developed itself. Besides, grid operators were not yet obligated to provide free grid access to all electricity generators ; as a result, the small-scale facilities responsible for most renewable energy generation found themselves either denied access to the grid, or discouraged from accessing it.

[53] Stromeinspeisungsgesetz.

The legal way of improving renewable energies in Germany



Source: http://www.wind-energy.de

Renewable Energy Law (EEG[54]) - 2000

The key instrument of the german policy is the Renewable Energy Federal Law adopted in April 2000. It fixes a minimal *feed-in tariff* and obligation for the operator of the electrical grid to buy renewable energies. The feed-in tariffs of each type were raised for every type of renewable energy, making each of them more attractive and profitable. Furthermore, the remuneration is reduced every year to support the development of new technologies and give opportunities for new producers to enter the market. The grid operator is also legally obliged to provide free access to the grid for all interested generators. The caracteristics of the tariffs fixes by the EEG are in the following :

- **Between 3,5 €-cents and 43 €-cents per kWh**
- **Tariffs guaranteed for a period ranging between 15 and 20 years.**
- **Economic incentives and stability incentives**
- **A annual decrease of the tarrifs, from 1% to 10% which plays the role of an incentive for developing new technologies and improving energy efficiency.**

In 2002 was settled in Berlin the German Agency of Energy (DEnA[55]) as the center of excelency in the area of energy efficiency and renewable energies. The government possesses 50% of the agency as the other 50% are the charge of a conglomerate of banks and insurance companies. Its targets are :

- Increasing significantly the use of renewable energies for the energy supply.
- Improving the competitivity of the renewables energies
- Promoting the renewable energies on the international level
- Integrating the renewable energies in the national infrastructure.

[54] Erneuerbare Energien Gesetz.
[55] Deutsche Energie-Agentur GMBH.

Tariffs EEG for various technologies

Type of energy	Duration (years)	€-cents/kWh	Annual reduction
Hydrolics	20 (facilities < 5MW) 15 (facilities 5 - 150MW)	3.5 – 12.7	0% (facilities < 5MW) 1% (facilities 5 – 150MW)
Biomass	20	7.8 – 11.7	1%
Geothermics	20	10.5 – 16.0	1% (as from 01/01/2010)
Wind onshore	20	5.0 – 9.2	1%
Wind offshore	20	3.5 – 15.0	2% (5% as from 01/01/2015)
Photovoltaic	20	32.0– 43.0	8 – 10%

Source : Revising the Legislation on Renewable Energy Sources in the Electricity Sector and Amending Related Provisions - 2008

The EEG was successful. **Indeed, in the past 8 years, the electricity generation from renewable sources has been multiplied by a factor 3**. Today Germany is the second world's leader with reference to its wind energy installed capacity, but it counts also the second world's market of photovoltaic energy. Furthermore, it counts with the first european market of solar thermics.

An example : EEG's incentives for wind energy

- For **onshore wind installations**, the basic tariff paid for electricity amounts to 5.02 €-cents per kWh. But the initial tariff paid in the first five years after the installation is commissioned and amounts to 9.2 €-cents per kWh. This five years period is extended by two months for each 0.75% of the fall below the output goal of 150% of the baseline yield[56]. Once extended, the period may not exceed 20 years[57]. The annual percentage degression for initial and basic tariffs is 1.0%. Since 2004, the grid operator is not required to reimburse energy from wind energy installations if their output is lower than 60% of the baseline yield.
- Concerning the installations that come in **replacement** of other installations, the initial tariff increases by 0.5 €-cents per kWh under two conditions : the installations that are replaced must be more than 10 years old, and the capacities of the new installations must amount to at least two times and at most five times that of the installations they replace. The annual percentage degression for tariffs is also 1.0% in that case.
- For **offshore installations**, the basic tariff paid for electricity amounts to 3.5 €-cents per kWh. But the initial tariff paid in the first twelve years after the installation is commissioned and amounts to 13.0 €-cents per kWh, with an increase of 2.0 €-cents for the installations commissioned before the 1st of january 2016. This twelve year period can be extended in the case of electricity installations located at least 12 nautical miles seawards and in a water depth of

[56] The baseline yield can be determined for each type of installation, calculated on the basis of the power-wind speed curve measured by an authorised institution in the reference site.

[57] For example, a wind installation which generated 120% of the baseline output would gain 5 years + (0.30/0.0075)*2 months = 11 years and 8 months of increased compensation. In reality, all the installations in the country receive compensation during 20 years, the baseline yield being very requiring.

at lease 10 meters by 15 days for each full nautical mile beyond 12 nautical miles and by 1.7 months for each additional full meter of water depth. The annual percentage degression for initial and basic tariffs for offshore installations is 2.0% and will be 5.0% from the years 2015 onwards.

The future

According to the Lead Scenario 2008[58] the contribution of renewables to electricity supply by 2020 will grow to just under 180 TWh/yr, which is 30% of gross electricity consumption[59]. Renewable generating capacity installed should totalize 70 GW in 2020, twice the figure of 2007. Renewable generating capacity newly installed since 2000 produces more electricity in each year than the quantity lost due to the phase-out of nuclear power up to the respective year.

The expansion of renewables in accordance with the forecasts should maintains an investment volume of approximately €12 billion per year. This improves the prospects of maintaining technology leadership in many renewable energy technologies and of further developing export markets. Annual investments rise to more than €15 billion per year after 2020. Cumulative investments in renewable energy facilities between 2008 and 2020, according to diferent scenarios, can figure beteween €160 and 190 billions.

Electricity generation from renewable sources according to the Lead Scenario 2008

TWh/yr	2000	2007	2010	2015	2020	2025	2030	2040	2050
Hydropower	24.9	20.7	22.5	23.9	24.3	24.5	24.6	24.8	24.8
Wind onshore	7.6	39.5	46.0	60.7	87.2	114.7	142.2	186.7	209.3
Wind offshore	-	-	1.2	11.1	33.7	58.9	84.1	123.0	142.4
Photovoltaics	0.1	3.5	6.2	11.0	15.5	18.7	21.9	25.3	27.7
Biomass	4.1	23.7	30.2	39.8	46.2	48.8	51.4	53.8	53.8
Geothermal	-	-	0.1	0.6	1.8	3.9	6.0	14.7	35.7
Solar thermal	-	-	-	-	1.0	8.5	18.2	52.0	91.0
Other	-	-	-	-	2.0	10.9	17.6	30.0	30.0
Total	36.7	87.5	105.1	136.1	178.2	230.0	282.1	387.2	472.4
Share (%)	**7.2**	**17.2**	**19.3**	**25.0**	***34.8***[1]	**44.9**	**53.9**	**73.6**	**87.0**

[1]The five scenario variants present values between 32.6% and 42,8%.
Source : Lead Scenario 2008

d. The benefits of wind energy in Europe

The cost advantage and its future

In Spain

[58] Further development of the « Strategy to increase the use of renewable energies » within the context of the current climate protection goals of Germany and Europe (study commissioned by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)), Dr. Joachim Nitsch Stuttgart, in collaboration with the Systems Amalysis and Technology Assessment Department of the DLR Institute of Technical Thermodynamics, october 2008.

[59] In 2030 renewables already should cover 50% of gross electricity consumption.

In terms of costs, **the sucess of the Feed-In Tariffs system in the countries involved cannot be denied**. For example, the Association of the Wind Energy Companies[60] of Spain estimated that the profit for the spanish electricity system during 2007 has increased to €14 for each MWh generated from the wind source. Indeed, the 2007 wind energy generation reached 27 TWh, which induces a saving of 5.5 millions of tons of fossil fuels whose market value was €1000 millions (37 €/MWh). In addition the emission of 18 millions of tons of CO_2 has been avoided[61], and they are evaluated at a market price of 20 €/ton, thus they would have totalized €360 millions (13 €/MWh). With the feed-in tariff system, in 2007 the spanish system paid €990 millions of compensations (37 €/MWh)[62]. Thus the savings is €370 millions (14 €/kWh)We can also note that the profit was also positive in the 2004-2006 period in despite of the lower prices of fossil fuels.

In Germany

In Germany, the main critics said that the EEG's compensation rates were to high according to the benefit that was induced. For example, the photovoltaics only contributed 0.25% to the national energy production in 2006 and nevertheless they cost about €1.000 millions for 2.000 GWh of electricity generated. Compared to the price of the ton of CO_2 spared within the carbon credite certificate part of the European Union's emissions trading system, the cost of the ton of CO_2 spared through the EEG policy in the photovoltaic sector is 30 times higher[63] : around €900.

However, photovoltaics can be considered as a separate case, as their price is especially high in respect of their benefit. But **concerning wind energy, the generation of more than 30.000 GWh has cost only €3.000 millions**. Thus, photovoltaics are currently five times more expensive than wind energy. More generally, the cost of wind energy in the EU was estimated to 1.300 €/MW onshore and 2.300 €/MW offshore in 2007[64]. These figures should drop to 1.150 €/MW and 2.300 €/MW respectively in 2010 ; 826 €/MW and 1.274 €/MW in 2020 ; at last, 788 €/MW and 1.206 €/MW in 2030[65].

According to the Lead Scenario 2008, « with realistic energy price developments the production costs of the renewable electricity mix will be lower in 2020 than those of fossil electricity supply ». If photovoltaic production[66] is excluded from the calculation, that point will be reached by 2015. Further expansion of renewable generation leads to a stabilisation of electricity production costs at approximately 8.5–9 €-cents per kWh.

The annual additional costs[67] of the entire expansion of renewable production figured €6.7 billion per year in 2007. Of this, 57% is due to the electricity supply. These costs should rise to €8.5 billion per year in 2010, before dropping significantly afterwards. Around 2022, there may be no more additional costs. By that time renewables should cover 20% of the country's total energy consumption and already avoid the emission of 200 millions tons CO_2 per year.

[60] Asociación Empresarial Eólica.
[61] Other emissions have been avoided : 11.000 tons of NO_x and 34.000 tons of SO_2 which can also be enhanced.
[62] Datas gather by the Cámara Argentina de Energías Renovables.
[63] FAZ article on photovoltaics, based on a study of the Rhine-Westphalia Institute for Economic Research, RWI.
[64] In 2005 prices.
[65] European Wind Energy Association, 2008.
[66] Even if their prices are still high, they are decreasing significantly due to current increased production of silicon, which is the main raw material to build solar pannels.
[67] Overcosts generated by choosing renewable instead of conventional energies.

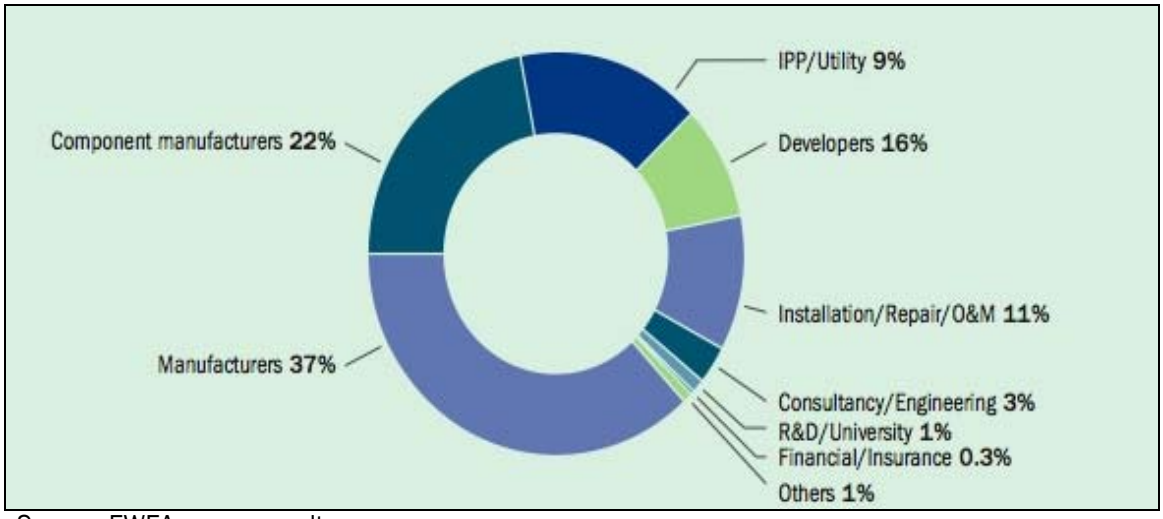
Today many economists encourage to take into account the mean CO_2 avoidance costs. They are currently estimated at €55 per ton of CO_2 for the renewable electricity mix according to the Lead Scenario 2008. These costs should drop to €14 per ton by 2020. The avoidance costs of the total mix in the heat sector presently figure €70 per ton of CO_2. For biofuels they are presently relatively high at 270 €/t. If the cost of the renewable energy has to be compared to the cost of other types of energies, this external cost has to be incorporated, taking for example €70 per ton of CO_2 as a reference value : therefore, **we would already arrive today at an electricity price of about € 10 cents per kWh**. In comparison with the full costs of fossil electricity generation, renewable electricity actually presents a great advantage, because it saves today approximately €1.2 billions per year, a figure that could rise to €14 billions per year by 2020. Ultimately, we can see the economic benefits of the EEG. Still, the price of fossil fuels remains variable and the benefits could be reduced or improved, depending of this variation. Furthermore, it also depends of the price of emissions rights part of the emission trading system.

Employement

The reneweable energy sector creates jobs, both in the development of the technology itself (innovation, for example) and the installation of the technology and its operation and maintenance.

According to several sources, the EU wind energy sector directly employed about 108.600 people in 2007[68], which represents an 125% increase compared to the same figure in 2002. This figure takes into acount employment within wind turbine manufacturing companies, and components manufacturers, wind energy project developers, utilities/Independent Power Producers (IPP) selling electricity from wind energy and major research and development (R&D) engineering and specialised wind energy services.

Direct employment by type of company



Source: EWEA survey results

[68] EWEA survey; ADEME, 2008; AEE, 2008a; DWIA, 2008; Federal Ministry of the Environment in Germany, BMU 2008.

If we add indirect employments[69], this figure reaches 154.000 people. Wind turbine and component manufacturing are responsible for 59% of direct wind energy employment. If the three leading countries (Denmark, Germany and Spain) are responsible for 75% of these jobs, the proportion was much higher in 2003, when these three Member States accounted for 88% of EU employment. According to a recent study[70] conduced by the European Wind Energy Association (EWEA), **15.1 jobs are created in the EU for every MW of wind energy installed**. In addition, 0.4 jobs are created per MW of installed capacity in operations and maintenance and other activites.

The jobs that were created by the wind energy activity have been highly involved in revitalising local communities, as a consequence of wind turbine manufacturing and related activites.

EWEA's baseline scenario predicts 328.690 jobs for 2020, almost half of them concerning offshore activity. In 2030, the figure should reach 377.244 jobs, about 57% of them linked with offshore activity, as by that time, the jobs created for every onshore MW should be reduced to 11, plus 0.29 per installed MW.

Direct employment from wind energy companies in European countries

Country	No. of direct jobs
Austria	700
Belgium	2.000
Bulgaria	100
Czech Republic	100
Denmark	23.500
Finland	800
France	7.000
Germany	38.000
Greece	1.800
Hungary	100
Ireland	1.500
Italy	2.500
Netherlands	2.000
Poland	800
Portugal	800
Spain	20.500
Sweden	2.000
United Kingdom	4.000
Rest of EU	400
TOTAL	108.600

Source: EWEA, 2007

In terms of comparison, in the USA some analysts believe that about 4.2 millions of jobs could be created over the next three decades, considering the fact that currently 750.000 people actually work in the renewable energy field[71], directly or indirectly.

[69] Indirect employments are the employees of the wind turbine or component manufacturing which are not directly involved in the industrial process ; but the activity of manufacturing generates activity and gestion within the company and therefore jobs are created.

[70] Wind At Work – Wind Energy and job creation in the EU, EWEA, January 2009.

[71] US. Conference of Mayors, september 2008.

Reduction of the emissions : less negative externalities

Any form of renewable production of electricity is an activity beneficial to the atmosphere. Indeed, they emit significantly less greenhouse gases than other forms of energy, not only CO_2 but also other contaminating gases, like the NO_x or SO_2 which have a bad impact on human health.

Renewable energies produce greenhouse gases throughout their life cycle : manufacturing, transport, mounting, operation, and dismantling. For example, as regards wind energy, the manufacturing phase concentrates 90% of all the life cycle's emissions.

Nevertheless, renewable energies emission's share is one of the lowest compared to the other types of energies:

Quantity of CO_2 emited per each kWh produced (in grams)

	Low hypothesis	High hypothesis
Coal	860	1290
Oil	670	900
Natural Gas	480	780
Hydrolics	4	18
Nuclear	8	59
Wind	11	75
Photovoltaics	30	280
Biomass	0	116

Source: French Atomic Energy Center, 2006

Not only the reduction of greenhouse gases emissions has a financial impact considering the possibility to sell Emissions Certificates, but also in terms of future costs. Indeed, the future public spending in respect of contamination or public health could be considerable if nothing is done to reduce the damage. For example, a report of the World Bank in 2007 points out that China looses 5.8% of its PBI due to the contamination of the atmosphere and of natural waters.

In 2006, speaking about the cleaning of the Riachuelo, official technicians were saying that it would cost US$ 3.000 millions over 10 years, while other proposition were forecasting US$ 400 millions over 4 years. In any way, **they are considerable spendings, and they are at the charge of the State, because contamination is a negative externalities**, which means that the industries that are contaminating do not pay for the costs that are generated.

2. How and why renewable energies have to be developed in Argentina

a. Argentina's policy concerning renewable energies

Since its ratification of the Kyoto Protocol, the Government, through the Secretary of Energy, impulsed a mechanism of consultation, with more than 300 stakeholders related to the sector. Some analysis have been realized through institutional links and they allowed to identify the barriers that prevent the country to develop an efficient renewable energy insertion. These inquiries have been financed by the Renewable Energy and Energy Efficiency Partnership (REEEP), a public-private non-profit international institution

whose aim is to catalyse the market for renewable energy and energy efficiency, focusing primarly on emerging markets and developing countries.

In the same time a study has been operated by the Secretary of Energy in partnership and with the technical contribution of the Bariloche Fundation, which is the executive in the project and which is a non-profit private institution whose aim is to promote scientific teaching and research.

Yet, the first results show how the development of renewable energies in Argentina is still marginal and far from reaching the target fixed by the law. Therefore, **the policies will have to be very incentive to allow Argentina to accomplish its objectives, as 1640 to 2000 MWe of renewable energy projects have to be materialized**[72].

The Law 25.019 : National Plan for wind and solar energies

This law voted at the end of 1998 presents several considerations about wind and solar resources. But over all, it is the first national law that implements financial incentives concerning these types of energies :

- Wind and solar energies are declared of national interest throughout the country.
- The payment of the tax on the value-added (IVA) for the investments in wind or solar equipments is differed for 15 years.
- The Secretary of Energy will increment its feed-in tariffs, granting a compensation of $ 0.01 for each kWh generated from wind energy[73] and provided to the MEM or some public facility, for a period of 15 years.

Nevertheless, **the law was regulated by the Decree 1597/99 which does not fix the economical incentives anticipated by the law**. It only says that the Secretary of Energy and the Cammesa will coordinate and fix the fees evocated in the law. But as we have seen it in the first part, the changes in the price system as well as the new regulation of the market from 2002, combined with the country's rapid growth, have increased significantly the electricity demand without clear incentives for the expansion of the supply, leading to the creation of the FONINVEMEN in 2008, whose purpose was the construction of the Belgrano and San Martín power plants.

The Law n°26.190[74] : Plan National for the use of renewable resources of energy destinated to electricity generation

This law was voted in december 2008 and represents a notable step towards the development of renewable energies, even if its targets are not ambitious enough and the way of achieving them remains obscure :

- **The proportion of renewable energies must reach 8% of the national consumption of electricity in 2016**. All sorts of renewable sources are considered ; with regard

[72] According to the Secretary of Energy, the figure depending on the increase of demand.
[73] Solar energy is excluded from this increase.
[74] Boletin Oficial n°31.064, Monday 2d of januar 2007 pp. 1-2. Ley 26.190 « Regimen de fomento nacional para el uso de fuentes renovables de energia destinada a la produccion de energia electrica ».

to hydrolics, only the facilities whose capacity is under 30 MWe are taken into account.

- **A Federal Program for the development of renewable energies will have to be elaborate** and should take into consideration various aspects of the challenge : technology, production, economics and financings necesary for the administration and the achievement of the target.
- The fifth article of the previous law (n°25.019) is replaced by the fourteenth article that modifies the compensation for the energy provided to the MEM as follows :
    - **Wind systems : $ 0.015 per kWh.**
    - **Photovoltaic generators : $ 0.9 per kWh.**
    - **Geothermics, biomass, tidal power, energy produced from common wastes, biogas : $ 0.015 per kWh.**
    - **Hydroelectricity (until 30 MW) : $ 0.015 kWh.**

  The producers will benefit from this compensation during a period of 15 years starting from the installation date.
- The fourteenth article also creates a fiduciary fund (FFER[75]) that will be financed by an additional charge on the total of the additional charge asked to the energy producers in order to finance renewable energy[76].

Still, **the amounts of the compensations are very low as they do not cover the difference between spot prices and average production costs**. For example, compared to the feed-in tariffs in Germany, the feed-in tariffs in Argentina for the wind energy onshore are about 17 times lower. Moreover, there is a lack of regulatory, as **the application Decree does not specify any amount and the uncertainty remains high about the effectiveness of the incentives**.

Besides, some studies have been made and draw the conclusion that the FFER will not be sufficient if it is not fed by more financial sources. **The law should propose other specific charges in order to expand the renewable energy industry**.

Provincial laws

Law n°12.603 : Province of Buenos Aires – 2001

The energy production from renewable sources is declared of provincial interest. Furthermore, the payment of the property tax to the new and existing intallations is exempted for 10 years. The producers will receive a compensation of **$ 0.01 for each kWh** provided to the MEM. This provincial reimbursement is to be added to the national reimbursement contemplated by the Law n°26.190.

The executive authority will promote special credits with long term financing and law interests rate through the Bank of the Province of Buenos Aires, to acquire the technology to use renewable energy sources and support their development. The Ministerio de Obras y Servicios Públicos will prioritize the electricity generation from renewable sources when it will allocate subsidies or finance the building of facilities.

[75] Fondo Fiduciario de Energías Renovables.
[76] This additional charge is currently $ 0.3 per kWh generated.

Law nº4389 : Province of Chubut – 1998

The wind energy production, distribution and consumption is declared of provincial interest. The payment of any provincial tax is exempted for 10 years to any activity of production of mechanical or electrical equipment in the wind energy sector. The producers will receive a compensation of **$ 0.005 for each kWh** provided to the provincial electricity grid or public facilities within the province. This provincial reimbursement is to be added to the national reimbursement contemplated by the Law n°26.190.

Law nº2796 : Province of Santa Cruz

The energy production from renewable sources such as wind, solar, tidal power, hydrolics until 15 MWe, biomass or other sources that do not pollute is declared of provicnial interest. The activities of production of mechanical or electrical equipment are exempted from paying any provincial tax. The producers will receive a compensation that rangin from **$ 0.01 to 0.03 for each kWh generated**, the value being determined by the percentage of integration of the equipments within the provincial and national systems.

A Provincial Fund for the Energy Development is created. Its resources comes from penalties for bad behaviours within the fossil fuels market, royalties of exploration and operation of fossil fuels deposits, subsidies contemplated by the National Law on Fossil Fuels n°17.319, dividends obtained fron the participation of the province in the capital of Enarsa, public and private contributions, contribution of the provincial budget.

The Fund will take in charge the distribution of the subsidies, promotion and financing studies and projects for the use of renewable sources of energy, financing and subsiding the construction of renewable energy facilities and equipments, training human resources and over all insuring the enforcement of the ley.

b. Current incentives

Clean Development Mechanisms (CDM)

After Russia's ratification of Kyoto Protocol, it was converted in international law and mechanisms like CDM have been established. This mechanisms offers to governments or private companies of industrialized countries the possibility to transfer its clean technologies to the developing countries, through investments in projects reduction of greenhouse gases emissions, recieving certificates that are valid for their internal reduction of emissions.

A project in the frame of CDM is a project that reduces the emissions or capture carbon and is developed in a developing country, like Argentina. The CDM projects generate Certified Emission Reductions (CERs) that are rights that can be exchanged on the carbon market[77]. **The benefits of CDM can make renewable energy projects more attractive to foreign investors from an economic point of view**.

Securing investments

The Law n°26.190, regulated through the Decree n°562/2009, fixes an additional compensation on the market prices for the renewable energy companies that meet the condition of granting their power to the grid and/or supply the electric utilities. The

[77] 1 CER equals 1 ton of CO_2 less emitted.

benefits established by the Law are an investment plan for 10 years and an additional compensation with regard to the market prices of energy according to various sources for a 15 years period. Indeed, it establishes an investment plan with tax reductions for the acquisition of capital goods and/or the completion of works that correspond to the aims of the plan, and the properties assigned to the activities of promotion prescribed by the Law n°26.190. Moreover, the tax of minimum benefits imposed buy the Law n°25.063 is excluded.

Securing the investments on the long term and in dollars encourage the landholders to rent their land to wind energy developers, if it is located in an area of high potential where the winds are constant and powerful (like the Atlantic coast of the Buenos Aires province or Patagonia) and of course, near the distribution grid. Installing wind turbines does not lead to major environmental impacts on the areas concerned, since they coexist with agriculture activities and their profits and because the contract include the dismantling of the turbine once the 15 years delay is reached. Therefore, this Law represents an important step for the beginning of a national wind energy industry. Still, it remains to create the nodes of connection with the areas concerned.

Still, the Decree does not specifiy the amount of the compensation. There is a high uncertainty concerning the implementation of the Decree. The additional compensation may not be sufficient.

Provincial incentives

Some provinces can accelerate the development of renewable energies, using tax credits. For example, the province of Néuquen through its Agency for the Development of Investments (ADI-NQN) recently called investors to start a campaign of wind speeds measurements in 6.600 hectares of fiscal property. The target being to evaluate the faisability of wind energy projects : installation and operation of wind farms whose electricity generation would be destinated to be implemented in the grid. These projects will need an investment of about $US 60 millions[78].

The company that will be chosed to this campaign will benefit tax credits, on the earnings as well as on the value-added. This call is the direct consequence of the Decree n°1837 from last september, through which the Governor Jorge Sapag wanted to reserve fiscal lands permanently and with a public utility purpose : the development of wind farms.

The lands were selected by the ADI-NQN, meeting the minimum conditions to be attractive : they are located near the electrcity transport lines of low and high voltage, they benefit from a good weather with a high wind potential. The investors have to take in charge the campaign of wind speeds measurements and evaluation of the wind resource. If they show good results, they would propose the installation of a wind farm whose dimension will depend of the wind intensity and the capacity of electricity transports, among others.

c. The current status of wind energy in Argentina

The installed wind energy capacity

[78] Cronista, Monday, october 19, 2009.

First, it seems important to remind that the use of wind resource in the country is not recent. The wind mills that are used by the farmers to extract water are traditional and there are about 400,000, most of them being in the Pampa. If these low power wind mills were due to be replaced by electrical infrastructures, it would need a power of 350 or 400 MW.

Since the oil crisis of 1973 and 1979, some projects have been started concerning alternative energies. Between 1985 and 1989, projects have been multiplied, and from a partnership with Germany, a wind farm has been installed. It was constitued of 4 wind turbines producing 30 kWe each, and connected to the thermic power plant of Río Mayo (South-East of the province of Chubut). In some other provinces (Neuquén, Buenos Aires, Catamarca) have also been installed turbines of smaller potencial (1 or 2 kWe), both for experiments and supplying infrastructures located far from the electricity grid.

Wind turbines in Argentina in 2009

Province	Locality	Quantity	Start-up	*Capacity* (MW)	Average speed (m/s)	Output (%)
Buenos Aires	Claromecó	1	Dec 98	0,8	7,3	18-25
	Darragueira	2	Oct 97	1,2	7,4	20-30
	Punta Alta	1	Feb 95	0,4	7,3	20-27
	Punta Alta	3	Dec 98	1,8	7,8	23-33
	Tandil	2	May 95	0,8	7,2	23-26
Chubut	C. Rivadavia	2	Jan 94	0,5	11,2	41-45
	C. Rivadavia	8	Sep 97	6,0	11,2	36-45
	C. Rivadavia	16	Oct 01	10,6	11,2	36-45
	R. Tilly	1	Mar 96	0,4	10,8	41-45
La Pampa	Gral. Acha	2	Nov 02	1,8	7,2	28
Neuquén	Cutral Có	1	Oct 94	0,4	7,3	22-26
Santa Cruz	Pico Truncado	4	Mar 01	2,4	10,3	46-49
San Juan	Veladero	1	Aug 08	2,0		
Total Pais		***45***		***29,8***		

Source: Camara Argentina de Energías Renovables, 2009

In 1994, year of the modification of the energy policy (that encouraged the private investments within the energy cycle, from the production to the distribution), some companies that fournished services began to be interested in the possibility of implementing wind generation of electricity. Indeed, en Comodoro Rivadavia (Chubut) were installed 2 turbines producing 250 kWe each, and because of the good results, 8 more turbines of 750 kWe each were installed in 1997. In Rada Tilly, another community near Comodoro Rivadavia, a turbine of 400 kWe was also installed in 1996. At the end of 1998, the country's total capacity is 14.000 kWe.

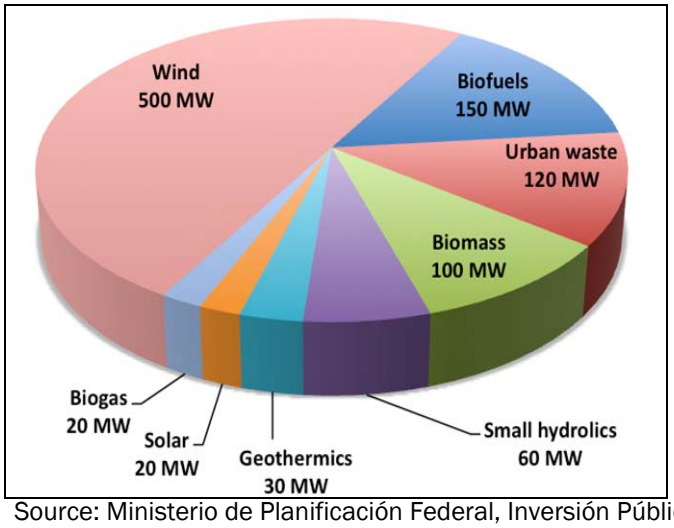
The last installation has been a wind turbine of 2 MWe, installed by the company Barrick in its mine Veladero, in the province of San Juan. In total, **the installed capacity of 29,8 MWe is very small compared to the installed capacity of leading countries in wind energy, but also regarding the great potential of Argentina's territory**, like we will have the occasion to see it in the continuation.

Program GENREN (Electricity generation from renewable sources)

Following the national law n°26.190, Energía Argentina Sociedad Anónima (Enarsa) will tender the purchase of electricity from renewable sources. The projects that could be accepted will have a capacity under 50 MWe. Enarsa will sell the electricity induced to the MEM through contracts for 15 years.

According to the Secretary of Energy, the total amount of investments is estimated to $US 2,500 millions. More than 8.000 jobs are expected to be created. The GENREN program should have an impact on the system of electricity distribution within the country and on the provincial policie, promoting regional economies. Indeed, an agreement between the National Association of Metallurgic Industries (ADIMRA[79]) and Enarsa schedules the definition of a mechanism for the evaluation and certification of projects that maximize the incorporation of local components and stimulate the national industry and thechnological development.

1000 MW of renewable energy power tendered by Enarsa with contract for 15 years



Source: Ministerio de Planificación Federal, Inversión Pública y Servicios

A half of the 1000 MWe desired by the program[80] is aimed to be generated by the wind resource. Nevertheless, Enarsa does not seem to develop rapidly enough its projects, as it invest only in a 60 MW project (Vientos de la Patagonia), and this projects is not really advanced ; indeed only the two first turbines have been installed yet. Besides, the major scenarios predict that to accomplish the targets of the law n°26.190, not less than 2500 MWe will have to be produced from renewable energies by 2016. Until 2025, 1000 MWe would have to be added. **Nevertheless, until now the State does not seem to improve its efforts trying to reach the tragets**. In despite of the National Strategic Plan for Wind Energy, which was proposed in 2005, only a 2 MWe turbine has been built yet. Today, only low potential wind farms are being installed, whereas the country should start the realization of projects of greater magnitude.

[79] Asociación de Industriales Metalúrgicos de la República Argentina.
[80] Announcement made by the Secretary of Energy Daniel Cameron, on May 20th, 2008.

Projects of wind farms

The National Strategic Plan for Wind Energy (PENEE[81]) impulsed by the government schedules the installation of at least 300 MWe of wind turbines. It included the measurements of wind speeds and the elaboration of a wind map of the country. The Regional Center of Wind Energy (CREE) took it in charge.

Then, various projects were proposed, but there is very few information on their schedule. These projects are the followings:

Current wind farms projects in Argentina

Region	Project	Capacity (MWe)
La Rioja	Arauco	90
Buenos Aires	Vientos del Secano	50
Chubut	Malaspina	80
	Vientos de la Patagonia 1	60
	Diaderna	6,3
Santa Cruz	Vientos de la Patagonia 2	N/d

Source: Cámara Argentina de Energías Renovables.

- **Vientos de la Patagonia 1 and 2 :** these projects are financed by the national government and local government : Enarsa participates in 80% and the province of Chubut participates in 20%. The first step of the project is already achieved : the installation of 2 prototypes of wind turbines (one from IMPSA and the other from NRG Patagonia). The second step is the installation of a 60 MWe farm in Chubut, using the wind mills certified in the first step. Vientos de la Patagonia 2 is linked with the province of Santa Cruz and plans the installation of wind farms in this province. Currently several studies of characterization of the wind resource are being made.
- **Parque Eólico Arauco :** it is a project led by IMPSA in the province of La Rioja and it plans the installation of 12 wind turbines of 2,1MWe that would totalize a capacity of 25,2 MWe. The first step that was achieved last july was to build the first wind turbine. The 11 other turbines should come into operation in may 2010. The aim of the project is to reach a total capacity of 90 MWe, which represents 45% of the province's demand of electricity.
- **Malaspina :** the Central Eólica Pampa de Malaspina S.A. is in charge of this project. It represents 40 turbines of 2 MWe, each one being installed in the area of the Pampa Malaspina, 130 km at north of Comodoro Rivadavia, in the province of Chubut. It should come into operation in 2011.
- **Vientos del Secano :** this wind farm should have a capacity of 50 MWe and its construction should begin in the last quarter of 2010. It will be located in the area

[81] Plan Estratégico Nacional de Energía Eólica, 2005.

of Ing. Buratovich, 50 km at the south of Bahía Blanca, in the province of Buenos Aires. It should come into operation at the end of 2011.

- **Diadema (Hychico/Capex) :** this wind farm will be located near Comodo Rivadavia and should have a capacity of 6,3 MW (7 wind turbines of 0,9 MWe each). It will also include facilities for the production of hydrogen. The wind farm was due to come into operation in 2010, but the last informations say that it is temporally suspended.

Wind turbines producers

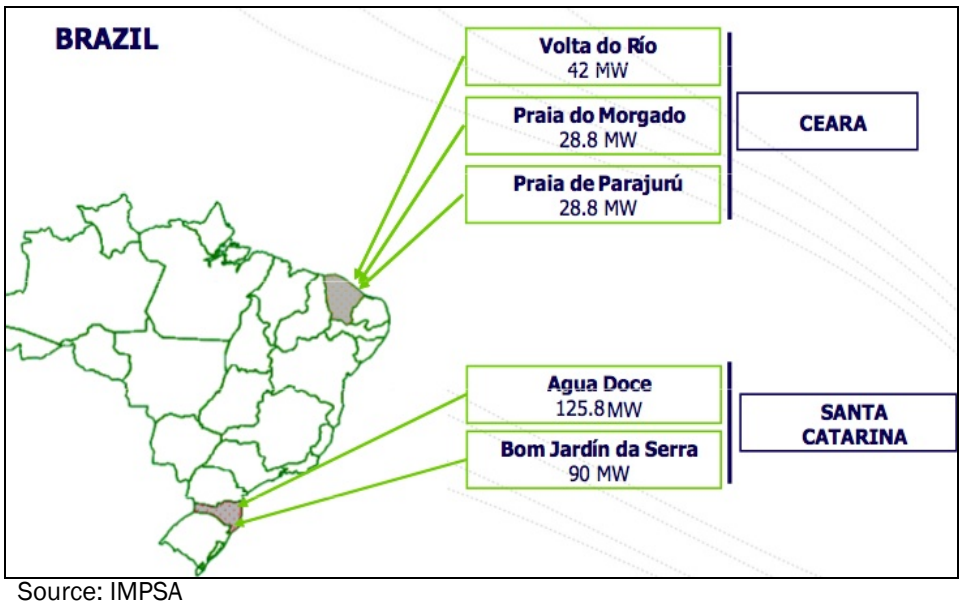
There are 3 companies that produce wind mills in Argentina :

- **Investigacion Aplicada (INVAP SE)**[82], which has its own technology of low power wind generators, to be used in remote areas. It is currently developing a 2 MW wind mill for winds of Class 2 (soft winds) and a 1,5 MW wind mill for winds of Class 1 (intense winds) destinated to places of higher wind resources (Center and South of Patagonia, Atlantic coast of the province of Buenos Aires). Its first installation should be in San Carlos de Bariloche, with a 5 MW wind farm constituted by 8 wind mills in the first stage. The second step should see the farm reaching 15 MW[83]. The company is also studying the wind resources in the country and making plans for other possible wind farms sites.
- **Industrias Metalurgicas Pescarmona S.A.I.C.& F (IMPSA)**[84] which has developed a large range of wind mills, that can be adapted for all kinds of winds and whose capacities are of 1,5 MW and 2,1 MW . Today it is in the phase of developing the technology for a 3 MW model[85].

  IMPSA possesses its own production centers, one is located in Mendoza and able to build 75 wind mills of 1,5 MW per year, another is located in Lumut, Malaysia and its capacity is 50 wind turbines per year. The last plant is located in the Port of Suape, Brazil and should enter serial production of large turbines and generators in June 2010, its annual production capacity being 300 wind mills of 1,5 MW per year. The company enters the business on the whole value chain: research and development, manufactureing, building farms and energy generation. Furthermore, IMPSAWind is the first wind energy company of large scale in Brazil : 13 wind farms are in the process of being installed in the North-West and South of the country, that totalize some 315 MW.

[82] INVAP SE is a public research company in engineering development.
[83] http://www.invap.net/indus/eolica.
[84] IMPSA is a argentinian private company that provides hyrdopower and wind power equipments in Latin America all over the world.
[85] Datas can be found in the IMPSA Wind Catalogo 2009 or Hannover Messe - April 2009.

IMPSA projects in Brazil (315 MW)



Source: IMPSA

IMPSA participates in the development of projects in many provinces of Argentina (Buenos Aires, Chubut, Santa Cruz, etc). It has already installed a 1,5 MW wind mill in Chubut and envisages installing a 90 MW farm in La Rioja. Currently it is installing the first 2,1 MW wind mill, before entering in the second step : the addition of 11 identical wind mills.

- NRG Patagonia[86] which has a licence for a 1,5 MW wind mill for winds of Class 1[87]. NRG Patagonia is a joint vointure with a German institute, its techology of equipment being designed and classified in Germany for working with intense winds. Currently the company is finalzing the construction of the first unit that will be installed and certified for the achievement of the Vientos de la Patagonia project.

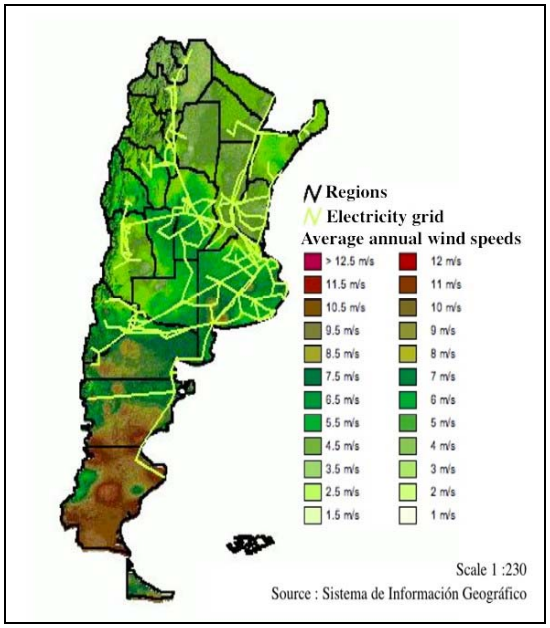
d. Frame of the wind resources in the country

The wind resources that could be used in Argentina are very high. 70% of the country's territory are covered by winds whose annual average velocity at a height of 50 meters over the ground exceeds 6 m/s[88]. More particularly, a lot of areas in Patagonia are covered by winds whose average velocity lies between 9 m/s and 12 m/s[89]. **These conditions are said to be ideal because the wind is fast enough to ensure a good energy output but moreover, wind storms are rather rare** and therefore, the wind velocity exceeds rarely the limit of the existent models of wind turbines, that would have to be turn off if such wind storm would ocure. This range of wind velocity is better the one of the countries that already have a developed wind energy industry ; furthermore, Argentina's surface represents 90% of the 15 first countries of the European Union, and

[86] NRG Patagonia is a private company localized in Comodora Rivadavia and is a joint venture with the Deutsches Windenergie-Institut GmbH (DEWI).
[87] http://www.nrgpatagonia.com.
[88] Estado de la Industria Eólica en Argentina 2009 – Cámara Argentina de Energías Renovables.
[89] Wind speeds are in this range more than 6000 hours per year, representing a time profitability of nearly 70%.

65% of the entire European Union (27 countries), but the density of its population is 10 times lower.

Annual average wind velocity (m/s)

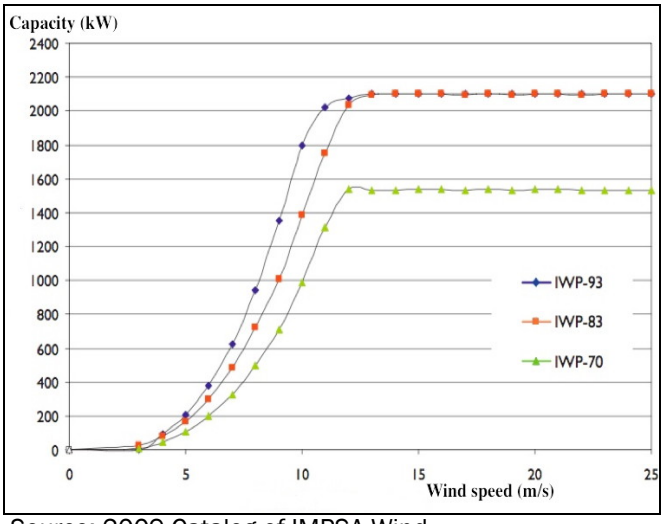


To summarize, not only the wind conditions are more relevant in Argentina than in many of other countries, but its surface is also an huge advantage because it insures a quasi unlimited energy resource.

In Argentina, a significant part of the territory offers wind conditions that insures a Capacity Factor (CF) high enough to install wind turbines. The Capacity Factor of a wind turbine is the percentage of the energy produced in one year with regard to the energy the turbine would have produced during the same year at its nominal output, working a 100% of the time[90]. Indeed, wind turbines often do not run at their nominal output, like this graphic shows it. If the wind velocity is lower than 3 m/s, no energy is produced. The wind turbines works at its nominal output only if the wind velocity is higher than 12 m/s. Between 3 m/s and 12 m/s, the output is increasing from being non-existent to being nominal. Ultimately, if the wind velocity exceeds 25 m/s, the turbine is turned off in order to protect its components.

[90] A CF of 45% means that the wind really produces 45% of the energy it would have produced in one year with its nominal output. The time period of reference is the year because the wind velocities change a lot, not only in function of the hour bot also along the year.

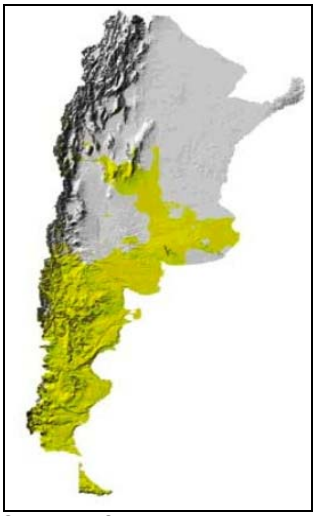
Electricity output in function of wind velocity for various models of IMPSA turbines



Source: 2009 Catalog of IMPSA Wind

The models of turbines that are already installed in Argentina show relevant results. Many areas in Patagonia offer a CF higher than 45%, but the winds are also very good in other parts of the territory, for example along the coast in the Buenos Aires Province, the CF is about 35%. In comparison, the average CF in Europe is about 25%. Therefore, **Argentina possesses a great and natural advantage compared to Europe, because the CF of wind turbines is in average 1,5 times higher than in Europe.**

Capacity factor > 35% at 70 meters height



Source : Centro Regional de Energía Eólica
Ministerio de Planificación Federal
Inversión Pública y Servicios

e. Barriers

With its high wind potential, Argentina is one of the best areas in the world to install wind turbines. Some studies point out that more than 2.000 GWe could be installed, that is to say 2 times the actual electricity capacity of the USA.

Various studies[91] have also highlighted other types of barries that prevent the implementation of renewable energies. **There are 5 types of barriers: technical, economical, legislative, institutional and social**.

Legislative barrier

- There is not any law that favorize or promote renewable energies with a fixed sell price that compensates the costs for several years. Furthermore, as we have seen it before, the targets fixed by the Law are not achieved because the Decrees remain unclear in respect of feed-in tariffs, for example.
- The compensations to the producers guaranteed in the national and provincial laws are not sufficient and discourage investors.
- The Cammesa is reluctant to the massive use of renewable energy because that would change the allocation of energy sources for the supply of the energy demand and furthermore, renewable energies would not provide a sufficiant security of potential. Indeed, one of the role of the Cammesa is to allocate the use of equipments in order to meet the demand. **There is a necesity to establish specific and legal standards for this allocation**.

Institutionnal barrier

- The energy policy and the environmental policy have to be combined pertinently, to impact on both the short and long term.
- Renewable energies are still very few institutionalized, receiving subsidies being very difficult.
- The legal sector should also support emissions measurements campaigns. Indeed, the institutional sector do not take into account externalities (positive or negative) as part of the energy production chain.
- There is a tendency of focusing on the extension of the grid to the detriment of renewable energy, while both the grid and renewable energy production go together.

Technical barrier

- The information about the renewable resource is insufficient.
- The resources are located in areas where the demand is low. Thus, if renewable energies have to be developed, it should come with the development of means of energy transportation. Neither transportation nor infrastructures are ready to stand for a wide energy production in remote regions.
- Except at IMPSA, the industrial development is still insufficient, either about design, operation, construccion or maintenance, even in respect of small scale projects.

Economical barrier

[91] Among which the one of the Bariloche Fondation, which has not been published yet.

- The investment costs are equals or higher than the marginal costs of the current system.
- There is a miss of private investments. Indeed, the major part of the installed equipments of wind energy are owned by cooperatives. The companies do not invest without the help of the State.
- There are difficulties in doing the paperwork, in the auction process as well as in the approach to draw benefits of incentives, even in small scale projects.
- The competitive development of renewable energy projects is still difficult, as the governmental subsidies to consumers are two high whereas financial incentives are too low.

Social and cultural barrier

- The population is not totally aware of the current issue of climate change, the population demand with regard to renewable energy is too low.
- Despite of the beneficial tool of the Clean Development Mechanism, at present state there is actually very few renewable energy projects under this banner in Argentina.
- Disparity in the consuming as a significant part of renewable energy consumers would be below the poverty line and they are not able to pay more.

These barriers underline the **necessity of a governmental leadership in matter of renewable energies**. Still, the SWOT analysis shows how their development could be profitable for both the country and investors.

f. Costs

At the end of 2008, the investments in wind farms using modern technology (turbines whose capacity is between 1 and 3 MW) were estimated at $US 1.8 to 2.2 millions per each MW. According to the Seceretary of Energy, which says that 50% of the future renewable capacity to be installed will be wind energy, the investments in this sector would be between $US 2.200 and 2.700 until 2016.

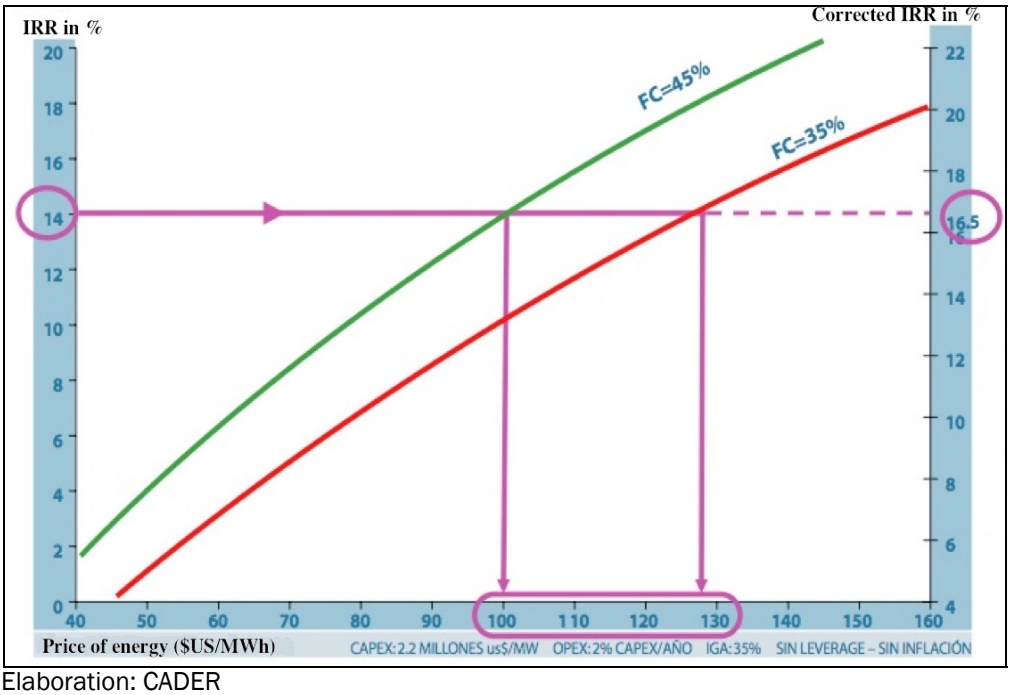
The Cámara Argentina de Energías Renovables (CADER) made an evaluation of the potential profitablity of a wind farm project taking as assumptions :

- An investment cost (CAPEX) of $US 2.2 millions per MW, without Value Added Tax (VAT).
- Operation and maintenance costs (OPEX) : 2% of the initial investments per year.
- Tax on profits (IGA): 35%.
- Amortisation of assets for the tax on profits : linear in 5 years.
- Credits for emission reduction : $US 20/ton of CO_2 with an emission factor if 0.6 ton/MWh.
- Without inflation and without leverage.

- The financial effects of the VAT or other national or provincial taxes were not taken into account.

The graph represents the curves of two find farms with two different CF (respectively 35% and 45%) : it is internal rate of return (IRR) in function of the energy price. The vertical axis on the left presents a neutral IRR in % whereas the one of the right takes into account the sale of greenhouse gases Emission Reduction Certificates (CERs) in the United Nation's frame of Clean Development Mechanism (CDM) considering a price of $US 20 per ton of CO_2. We can see that with a price between $US 100 to $US 130 per MWh, the projects are very profitable.

Theorical calculation of wind energy costs: IRR in function of the price in US$ per MWh for two different Capacity Factors (35% and 45%)



Elaboration: CADER

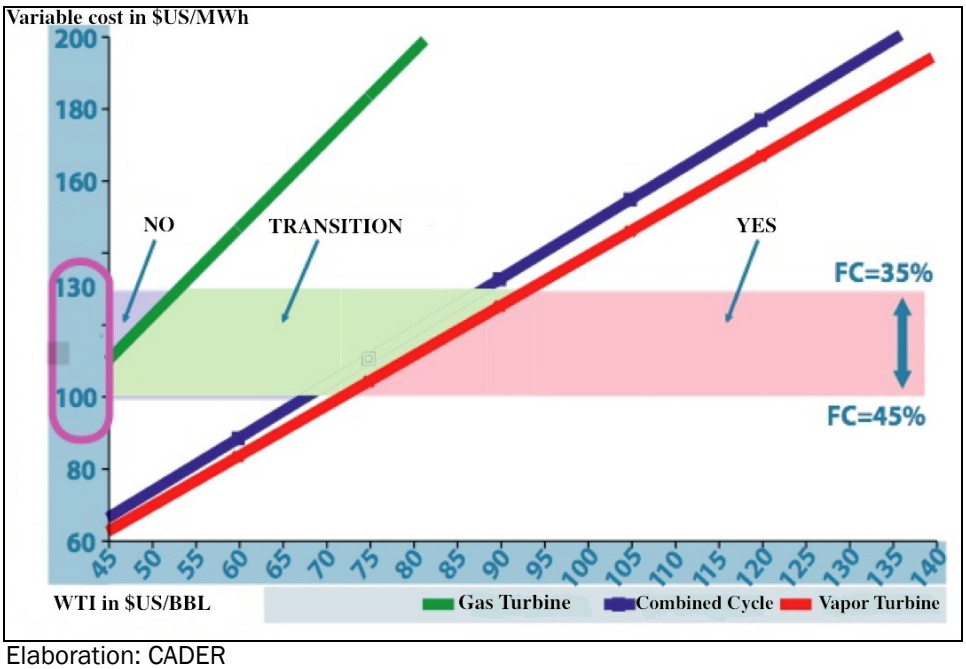
During the year 2008, an average of 3.300 m^3 of gasoil and 2.400 m^3 of fuel oil were imported only for electricity generation (from Venezuela and Brazil). They correspond to an amount of $US 1.800 millions. The costs of fossil fuels are relacionated to the international value of crude oil (WTI). Therefore, the consequences are not to be neglected : a high dependency on the geopolitical level, low power of planification, high generation costs which induce high public expenditure, according to the current system.

The next graph presents the electricity generation cost in $US/MWh in function of the WTI for various technologies (respectively gas turbines, combine cycles and vapor turbine). The study do not include the payment of the depreciation of facilites, because it is considered that the fossil fuel facilites are already in place and the initial invesments already reimbursed, and the strategy would be to substitute the use of such power stations by installing and operating wind farms.

We can observe that within a price range of $US 100 to 130 per MWh, **the wind energy begins to be competitive at a WTI of $US 40, compared with gas turbines**, only considering variable costs, as the investments costs have not been taken into account. In Argentina, the last major units are combine cycles power station, and there were built

while the WTI was increasing to over $US 100 in 2008, to drop significantly because of the world crisis. Today, while the world enters the post-crisis phase, the WTI has exceeded the $US 75 in november 2009. One can expect that it will continue to increase, as the economic activity will grow again. **Argentina cannot count on maintaining the WTI price down, because it critically depends on the international context and taking into account the future exhaustion of fossil fuels, the low price is only circumstantial. Besides, the study shows that starting at a WTI of $US 75, wind farms with a CF of 45% are highly profitable compared to any fossil fuel facility.** For private or public investors, the main opportunity is to remain independent of the volatility of fossil fuels prices ; the final prices structure, with more stable costs, would allow to improve the predictability both for final consumers and investors who would be able to better schedule long-term investments.

Variable generation cost with fossil fuels vs wind energy generation costs



Elaboration: CADER

The $US 1.800 millions spent by Argentina in 2008 for the purchase of fossil fuels and electricity allowed to generate 7.700 GWh ; therefore, the average electricity cost of production is 230 $US/MWh. The study shows that **if 15% of these spendings would have been intended to the purchase of wind energy with long term contracts, 680 MWe could have been installed, attracting invesments of about $US 1.500 millions.**

In conclusion, the study reveals that this kind of public policy would replace expenditures by investments, while saving and securing the energy mix and the energy independence of the country.

III. SUMMARY OF THE KEY POINTS AND CONCLUSION

1. Key points

a. Remarks about the country's economy and electricity market

- The country's electricity capacity is just sufficient to cover the average demand's growth in one year, whereas safety measures as well as a vision on the long term should encourage Argentina in forecasting the growth a lot more time in advance, especially if the country wants to preserve its energy independence.
- In the short term, Argentina needs at least a new 900 MWe power plant per year to cover its growth. In the long term, it may be even more.
- Considering the recent development of the electricity grid (especially in Patagonia), Argentina should take advantage of resources that can be found all over its land; indeed, the possibility of generating electricity would be directly implemented in the electricity grid. Still, more investments have to be made in transportation, with the aim of densifying the grid and increasing the number of connections with distant areas.
- The issue of social tariffs has to be solved. The way of selecting the homes that could benefit from social subsidies could be changed, for example, instead of considering the consumption as a basis, a new basis could be the income, the household's location in a poverty area or the way of life, that would have to be evaluated precisely, case by case.
- In Argentina, the energy sector is dominated by fossil fuels. Russia and Argentina are the biggest gas consumers in the world. Taking into account the fact that the demand

remains high and the resources are exhausting, Argentina is becoming more and more dependent on importations and therefore, looses its self-suffiency.

- The country sold more oil when the prices were low, and reduced its sells when the prices raised, because it became aware of their exhaustion. The lack of reserves could lead to cost much more than the investments necessary to recover them, because since they are running out and since the deposits are stoping their production, the oil equipments are abandonned and the contracts due to end. Today, there is a miss of investments in exploration and the policies should focus in stimulating them, for example by maintening high prices in order to stimulate them financially.
- Today more than before, Argentina should consider the recent decrease of activity as a breath of air which is a chance to make up for the lost time, because investments are absolutely necessary for the increase of the energy supply, and particularly for the electricity sector, both in its activities of production and distribution, because the country runs an important risk of having multiple power cuts, especially in Buenos Aires and its province.
- The policies should focus on promoting investments and redefining precisely the public sector as the state should ensure accurate legislation and real planification for the future.
- Above all, the energy mix has to be diversified.

b. Alternative energies: nuclear and hydropower

- Argentina can consider itself quite safe concerning any lack of uranium resources. However, if Argentina is due to continue and develop nuclear energy, it seems important to have the competences to control the whole nuclear cycle, from the extraction of uranium to nuclear waste management. But additional costs should have to be taken into account, and therefore the country will have difficulties to access, in the medium term, the nuclear energy strength necessary to avoid the troubles caused by the exhaustion of hydrocarbons. If Argentina wants to build new power plants, it appears essential to compare its nuclear energy policy with other alternative energy policies, as for the resources, costs, competences, technology and attractivity.
- For the moment, Argentina should focus itself in extending the lifetime of the two existing plants and achieving Atucha-2.
- Concerning nuclear waste management, the examples of northern Europe's countries could be easily applied in Argentina, as they chose in depth geological storage without previous retreatment. It is the cheapest and more accurate solution for this type of industry scale.
- Argentina should also encourage the development of the CAREM reactor project, as it could lead to great success and take a significant role in the country's production of electricity in the future. More generally, Argentina should support research in new nuclear technologies that could be more efficient and less polluting.
- The development of hydroelectricity founds itself in front of institutionnal, structural and social barriers that slow down the achievments of many projects and cannot ensure a reliable growth of the supply, both on the short and the long term. But the

main issue remains the way to finance these large structures, because there is a high uncertainty about their profitability. On one hand, it seems absolutely necessary to develop a plan of investments that includes borrowings to the Bank of Development or to the World Bank. But on the other hand, consumers will not be ready to pay more for their electricity, the recent example of gas prices shows how difficult it is to impose a raise of prices, especially in a crisis context.

c. Renewable energies

- The current crisis makes more clearer the changes of minds in occidental countries with regard to renewable energies, as most of these countries are in the process of developing renewable generation of electricity on a large scale. Argentina should also develop renewable energies on a large scale, in order to be part of the lead.
- The advantages of renewable energy is that it is inexhaustible. as well as it does not pollute the environment. Furthermore, the intermittency of all forms of renewable energies enlightens the idea of a development of various renewable sources, as they can supplement themselves, and therefore, create a relevant renewable energy mix.
- Argentina is far from reaching the target fixed lastly by the government: renewable energies must reach 8% of the national consumption of electricity by 2016. The renewable energy market is very delayed compared to most of occidental countries, but also to developing countries like China or Brazil.
- The country should elect relevant renewable sources in terms of social, environmental and economical profit and has to choose relevant means to develop them. The relevant sources are wind and solar.
- If the wind conditions in Argentina are said to be ideal, the installed capacity of 29,8 MWe is very small compared to the installed capacity of leading country's in wind energy. Furthermore, Argentina possesses a great and natural advantage because the potential output of wind turbines is 1.5 times higher than in Europe.
- Wind energy begins to compete with gas turbines at a WTI of $US 40. Starting at a WTI of $US 75, wind farms are highly profitable compared to any fossil fuel facility. Considering the fact that Argentina cannot count on maintaining the WTI price down, because it critically depends on the international context, and taking into account the future exhaustion of fossil fuels, the low price is only circumstantial. A relevant public policy would replace a part of the expenditures in fossil fuels by investments or subsidies, while saving and securing the energy mix and the energy independence of the country.

d. The international experience

- In leading countries, investments in renewable energies were made because the targets fixed by governments became legal constraints and not just indications.
- The European law leaves to its Member States the freedom of choice concerning policies of promotion, as well as their own responsability to reach a global and

constraining target, as long as they accomplish the target of at least a 20% share of energy from renewable sources in 2020.

- Today, 7% of Germany's electricity comes from the wind resource. The renewable energy sector profited the implementation of feed-in tariffs. Germany's national target is to generate 30% of its electricity supply with renewable sources by 2020. With realistic energy price developments the production costs of the renewable electricity mix in Germany will be lower in 2020 than those of fossil electricity supply.
- By using renewable sources, less negative externalities like contamination are being generated, and therefore less spendings are at the charge of the State.
- 15.1 jobs are created in the European Union for every MWe of wind energy installed.

e. Better public policies to face various difficulties

These barriers underline the necessity of a governmental leadership in matter of renewable energies. Still, the SWOT analysis shows how their development could be profitable for both the country and investors.

Legislative barrier

- There is not any law that favorize or promote renewable energies with a fixed sell price that compensates the costs for several years. Furthermore, as we have seen it before, the targets fixed by the Law are not achieved because the Decrees remain unclear in respect of feed-in tariffs, for example, and hence, the policies will have to be very incentive to allow Argentina to accomplish its objectives, as 1640 to 2000 MWe of renewable energy projects have to be materialized according to the law
- The compensations to the producers guaranteed in the national and provincial laws are not sufficient and discourage investors. They are very low as they do not cover the difference between spot prices and average production costs. Besides, the fiduciary fund anticipated by the law will not be sufficient if it is not fed by more financial sources. The law should propose other specific charges in order to expand the renewable energy industry.
- The Cammesa is reluctant to the massive use of renewable energy because that would change the allocation of energy sources for the supply of the energy demand and furthermore, renewable energies would not provide a sufficiant security of potential. Indeed, one of the role of the Cammesa is to allocate the use of equipments in order to meet the demand. There is a necesity to establish specific and legal standards for this allocation.

Institutionnal barrier

- The energy policy and the environmental policy have to be combined pertinently, to impact on both the short and long term.

- Renewable energies are still very few institutionalized, receiving subsidies being very difficult.
- The legal sector should also support emissions measurements campaigns. Indeed, the institutional sector do not take into account externalities (positive or negative) as part of the energy production chain.
- There is a tendency of focusing on the extension of the grid to the detriment of renewable energy, while both the grid and renewable energy production go together.

Technical barrier

- The information about the renewable resource in the country is insufficient.
- The resources are located in areas where the demand is low. Thus, if renewable energies have to be developed, it should come with the development of means of energy transportation. Neither transportation nor infrastructures are ready to stand for a wide energy production in remote regions. In each province should be allowed the possibility to connect and introduce energy to the electricity grid in safe conditions.
- Except at IMPSA, the industrial development is still insufficient, either about design, operation, construccion or maintenance, even in respect of small scale projects.

Economical barrier

- The investment costs are equals or higher than the marginal costs of the current system.
- There is a miss of private investments. Indeed, the major part of the installed equipments of wind energy are owned by cooperatives. The companies do not invest without the help of the State.
- There are difficulties in doing the paperwork, in the auction process as well as in the approach to draw benefits of incentives, even in small scale projects.
- The competitive development of renewable energy projects is still difficult, as the governmental subsidies to consumers are two high whereas financial incentives are too low.

Social and cultural barrier

- The population is not totally aware of the current issue of climate change, the population demand with regard to renewable energy is too low.
- Despite of the beneficial tool of the Clean Development Mechanism, at present state there is actually very few renewable energy projects under this banner in Argentina. But the benefits of Clean Development Mechanisms can make renewable energy projects more attractive to foreign investors from an economic point of view.
- Disparity in the consuming as a significant part of renewable energy consumers would be below the poverty line and they are not able to pay more.

2. Conclusion

The fight against global warming raise the issue of responsabilities. Two centuries of industrialization in developed countries of the northern hemisphere are responsible of the most significant part of greenhouse gases that are currently changing the climate. With other developing countries, South America is asking occidental countries to recognize their environmental debt, as serious climate issues are threatening the continent. Developing countries should have the right to develop themselves with an economy that would not be damaged by climate issues. « These countries have grown with the right to emit greenhouse gases and moreover they did not accomplish the Kyoto Protocol targets. That is why they have to make much more efforts and be aware of the different responsabilities »[92] says Homero Bibiloni, secretary of Environment and Sustainable Development.

Developing countries are asking occidental countries for financing and technology transfers in order to be able to change their energy mix. Moreover, they should not be obliged by international treaties to reach specific targets, says the G77 and China, as only developed countries should have to reach constraining targets.

In South America, some propositions are made but generally not listened. For example, Brazil proposes the creation of an international fund to finance the decarbonization of developing countries. « This fund cannot be under 350.000 or 400.000 million dollars per year. One can say it is a lot of money, but it is the fifth of what central banks gave in the current crisis. The health of our planet cannot receive less than the health of the finance sector because without planet, there is no finance sector » says Carlos Minc, minister of Environment of Brazil.

A study of the Center of International Economy of the Argentinian chancellery shows how Clean Development Mechanisms are distributed in the biggest developing countries: China received 35% of the projects, India 25%, Brazil 9% and Mexico 6%. In total, Asia recieved almost the 3 quarters of the projects and South America what was left[93].

Nevertheless, the South American continent is also responsible for 5% of the emissions and have to assume these responsabilities. But there is a lack of serious national programs and coordination plans. Indeed, the priority seems to be fighting against poverty before fighting against climate change. Although Osvaldo Girardín, searcher at the National Concil of Scientific and Technic Research (CONICET) and director of Environment at the Bariloche Fondation, warns that if countries do not fight against global warming, the social context and poverty will get worst, most of the countries are starting processes to change their energy mix, but these processes seem complex and heterogeneous, and planification on the long term is still missing; « Some people speak about winners and loosers but on the long term, we all loose » adds Girardín.

Furthermore, South American countries did not succeed in finding a common position, either in the frame of Mercosur or in the forums organized to prepare the Copenhagen Climate Conference that took place in december 2009: the Latin America and Caribean group or el G77. Among the reasons to this failure, there is a diversity of countries that leads to a diversity of issues. For example, the main challenge in Brazil is to control deforestation whereas in Argentina, it is to reduce its consumption of hydrocarbons. In this purpose, we have seen how Argentina should be able to develop renewable energy,

[92] Le Monde Diplomatique, december 2009.
[93] www.cei.gov.ar/serie/pdf/libro13.pdf.

and we studied wind energy as an example. Indeed, the country has a great role to play in this sector as its wind resources are unique in the world.

Still, Argentina also possesses another great asset : the solar resource. As photovoltaic pannels are still a developing industry, they are expensive and very criticized for the contamination due to the manufacturing process, to us the thermo solar sector would be more accessible to our economy and moreover, it seems to be one of the ways of the future: California is starting a large program that will implement some of the newest thermo solar power plants that should compete with nuclear power plants in terms of investments, energy capacity and output. They can even decline themselves for various scales: 100 MWe, 200 MWe and 500 MWe and thus, they can be implemented for local or national needs. Sun conditions are said to be practically identical in the desert of California than in the North-West of Argentina. Hence, solar energy could be the next step in order to diversify the energy mix.