

TRAINING COURSE ON BIOGAS TECHNOLOGY FOR LATIN AMERICAN, CARIBBEAN AND SOUTH PACIFIC COUNTRIES IN 2015- CHENGDU- CHINA

URUGUAY COUNTRY REPORT ON RENEWABLE ENERGY WITH EMPHASIS IN BIOENERGY AND BIOGAS

Verónica Perna - National Board of Energy - Ministry of Industry, Energy and Mining

Matías Cagno - Technological Laboratory of Uruguay

CONTENTS

1	Introduction to the country	1
2	Energy in Uruguay and Regulatory Framework of renewable energies	4
2.1	The National Energy Plan 2005-2030	4
2.2	Institutional framework in the energy area	5
2.2.1	National Board of Energy (DNE)	5
2.2.2	UTE	5
2.2.3	ANCAP	5
2.2.4	URSEA	5
2.3	Regulatory Framework	5
3	Energy supply in Uruguay	7
3.1	Energy supply matrix	7
3.2	Electric energy supply	7
4	Renewable energy by source	9
4.1	Hydroelectricity	9
4.2	Small Hydro Plants (PCH)	9
4.3	Solar energy	10
4.4	Wind energy	11
4.5	Bioenergy	14
4.5.1	Biofuels	14
4.5.2	Biomass	15
4.5.3	Biogas	16
4.5.4	Biovalor Project	21
4.5.5	Other activities in the bioenergy area	22
5	References	22

1 INTRODUCTION TO THE COUNTRY

Uruguay, officially the Eastern Republic of Uruguay, is a country in the south-eastern region of South America. It is bordered by Argentina to its west and Brazil to its north and east, with the

Atlantic Ocean to the south and southeast. Uruguay is home to 3.4 million people according to the last census (INE, 2013), of whom 1.8 million live in the metropolitan area of its capital and largest city, Montevideo. With an area of approximately 176,000 km², Uruguay is geographically the second-smallest nation in South America.

According to the HDI Human Development Report from the United Nations, Uruguay's HDI value for 2013 is 0.790— which is in the high human development category—positioning the country at 50 out of 187 countries and territories. Between 1980 and 2013, Uruguay's HDI value increased from 0.658 to 0.790, an increase of 20.0 percent or an average annual increase of about 0.55 percent.

Between 1980 and 2013, Uruguay's life expectancy at birth increased by 6.9 years, mean years of schooling increased by 2.2 years and expected years of schooling increased by 3.4 years. Uruguay's GNI per capita increased by about 106.9 percent between 1980 and 2013.

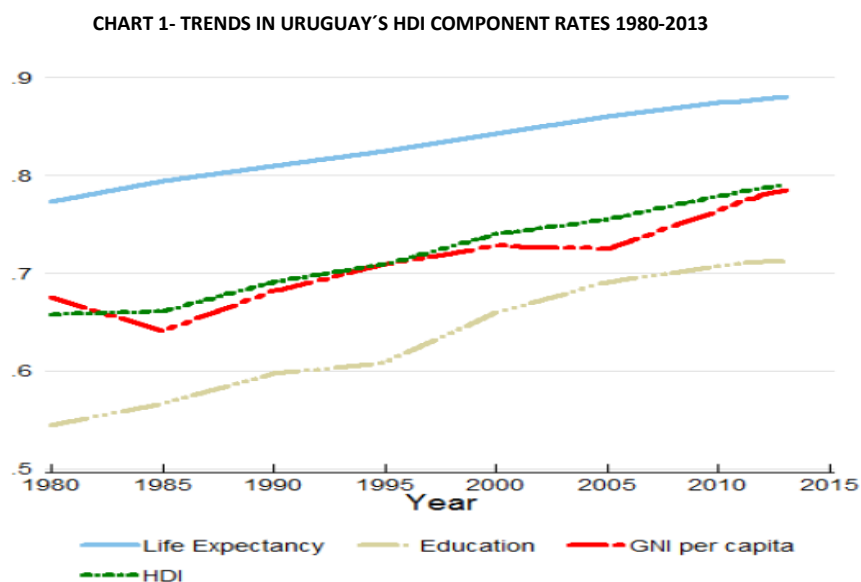


TABLE 1- DATA FROM WORLD HEALTH ORGANIZATION –[HTTP://WWW.WHO.INT/COUNTRIES/URY/EN/](http://www.who.int/countries/ury/en/)

Total population (2013)	3,407,000
Gross national income per capita (PPP international \$, 2013)	18,000
Life expectancy at birth m/f (years, 2013)	74/81
Probability of dying under five (per 1 000 live births, 0)	not available
Probability of dying between 15 and 60 years m/f (per 1 000 population, 2013)	148/79
Total expenditure on health per capita (Intl \$, 2013)	1,715
Total expenditure on health as % of GDP (2013)	8.8

Uruguay, with an area of 176,215 km², has landscape features mostly as rolling plains and low hill ranges with a fertile coastal lowland and 660 km of coastline.



FIGURE 1- MAP OF URUGUAY. SOURCE: INE- URUGUAY

A dense fluvial network covers the country, consisting of four river basins, or deltas: the Río de la Plata Basin, the Uruguay River, the Laguna Merín and the Río Negro. Several lagoons are found along the Atlantic coast.

The average height is 116.70 m with the highest point of 513.66 metres (Catedral Hill).

Located entirely within a temperate zone, Uruguay has a climate that is relatively mild and fairly uniform nationwide. Seasonal variations are pronounced, but extremes in temperature are rare.

The mean annual precipitation was in 2013 of 1110 L/m². It decreases with distance from the sea coast, and is relatively evenly distributed throughout the year.

The average temperature in the year 2013 was of 17.6 °C with a maximum temperature registered of 41.3 °C and a minimum of -4.9 °C.

Uruguay is a representative democratic republic with a presidential system. The members of government are elected for a five-year term by a universal suffrage system. Uruguay is a unitary state: justice, education, health, security, foreign policy and defense are all administered nationwide. The Executive Power is exercised by the president and a cabinet of 13 ministers.

Uruguay is divided into 19 departments whose local administrations replicate the division of the executive and legislative powers. Each department elects its own authorities through a universal suffrage system. The departmental executive authority resides in a superintendent and the legislative authority in a departmental board.

According to FAOSTAT, Uruguay top ten commodities produced are cattle, meat, soybeans, milk, rice, wheat, chicken, meat, sheep meat, grapes, wool and maize.

TABLE 2 AND TABLE 3- URUGUAY TOP TEN COMMODITIES. PRODUCTION QUANTITY AND PRODUCTION VALUE - 2012

Uruguay Top Ten commodities Production quantity 2012			Uruguay Top Ten commodities Production value 2012		
	Commodity	Quantity [t]		Commodity	Value [1000 Int\$]
1	Soybeans	3000000	1	Meat indigenous, cattle	1468804
2	Milk, whole fresh cow	2100000	2	Soybeans	807384
3	Rice, paddy	1424000	3	Milk, whole fresh cow	589795
4	Wheat	982000	4	Rice, paddy	389126
5	Meat indigenous, cattle	543724	5	Wheat	134071
6	Maize	528000	6	Meat indigenous, chicken	124935
7	Sorghum	372000	7	Meat indigenous, sheep	93038
8	Sugar cane	368000	8	Grapes	74310
9	Barley	220000	9	Wool, greasy	68872
10	Oranges	140000	10	Maize	52015
Source: FAOSTAT, FAO of the UN, Accessed on February 4, 2015. http://faostat.fao.org/site/567/default.aspx#ancor			Source: FAOSTAT, FAO of the UN, Accessed on February 4, 2015. http://faostat.fao.org/site/612/default.aspx#ancor		

2 ENERGY IN URUGUAY AND REGULATORY FRAMEWORK OF RENEWABLE ENERGIES

Uruguay has vast natural resources for the development of renewable energy, such as biomass, hydropower, wind and solar energy. The absence of fossil fuel resources (up to now) in Uruguayan economy and the exhaustion of hydropower capacities (at large scale) offer important opportunities to the introduction of new energy sources, such as renewable energy. The country has four hydroelectric plants, three of which are located on the “Rio Negro” and one on the “Rio Uruguay” (shared with Argentina). Too, there are power stations operated by steam turbines, gas turbines or engines using fossil fuels and private generators that use biomass. In recent years it has incorporated wind and solar generators, both private and public.

Also is important to mention other investments that are being done in the energy sector although not with renewable energies, like the combined cycle power plant at Punta del Tigre and a regasification plant.

With the regasification plant Uruguay will introduce large-scale natural gas for the purposes of diversifying its energetic matrix and supplementing the strong introduction of renewable energies. To implement this, the state-owned utilities, UTE and ANCAP, have set up the company Gas Sayago S.A. which dealt with hiring a service provider to build, operate and keep the liquefied natural gas (LNG) terminal and provide receipt, storage, delivery and regasifying services.

Also in Uruguay contracts for exploration and exploitation of hydrocarbons are currently running, both in land (onshore) as on the continental maritime platform (offshore).

In these activities major oil international companies (Total, Shell, British Petroleum, British Gas, Tullow Oil and Galp among others) are participating and they have hired geological and geophysical services that have allowed remarkable advances in the knowledge of the Uruguayan underground.

2.1 THE NATIONAL ENERGY PLAN 2005-2030

Uruguay has defined in 2005- 2008 a National Energy Policy (“Uruguay 2030”). In 2010, this long term energy policy was approved by a Special Committee including all political parties represented in the Uruguayan Parliament. It is based on 4 strategic pillars, short, medium and

long-term goals and many lines of action. One of the strategic pillars aims at the diversification of the energy mix, increasing the share of renewable energies. One of the most relevant short-term goals of the policy is to reach 50% of renewables in the global primary energy mix of the country by 2015. Many lines of action were launched in order to reach these and other goals. The introduction of wind and forest biomass energy has received assistance from the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP). The goal of the National Energy Policy states that, in the short-term, at least 30% of the total waste in the country shall be transformed into different types of end-use energy (electricity, heat, biofuels).

2.2 INSTITUTIONAL FRAMEWORK IN THE ENERGY AREA

2.2.1 National Board of Energy (DNE)

The National Board of Energy (DNE), executive unit within the sphere of the Ministry of Industry, Energy and Mining (MIEM), is responsible for preparing and coordinating the national energy policy. Among its main duties is the coordination and guidance of the stakeholder's actions when operating within the energy industry and participation in the development of the regulatory framework that governs energy activity. Website: www.dne.gub.uy

2.2.2 UTE

The National Administration of Power Plants and Electric Transmissions (UTE) is a State owned utility engaged in the generation, transmission, distribution and trading of electrical energy. Although Law 16,832 established the energy distribution freedom, actually and given the country's scale, it has the monopoly of this activity. As a result, private energy generators sell their energy to this company. Website: www.ute.com.uy

2.2.3 ANCAP

ANCAP is a state-owned company engaged in several activities in the production, distribution and trading market of fuel, alcohol and Portland cement. To operate in these markets, it participates as shareholder (in many cases as majority shareholder) or owner of several companies operating in some of these lines of business. With respect to the energy sector, it carries out activities related to natural gas and liquid fuel. Regarding renewable energies, the majority shareholder of the company ALUR is ANCAP.

2.2.4 URSEA

The Regulatory Agency for Energy and Water Services (URSEA) is the governing body of the sector; it was created as a decentralized body of the Executive Branch, with power to control activities in the electrical, gas and hydrocarbon markets, where the state companies mentioned above operate.

2.3 REGULATORY FRAMEWORK

Uruguay has many regulations in renewable energy. Below are shown some examples of important laws and decrees in this area.

TABLE 4- REGULATORY FRAMEWORK IN RENEWABLE ENERGIES IN URUGUAY – SOME EXAMPLES OF IMPORTANT LAWS AND DECREES

Law 14,694	National Electricity Law (1977)
Law 15,031	UTE Law (1980)

Law 16,832	Law 16,832 on the Electricity Regulatory Framework was passed in September 1997 and endorsed by citizens in 1998 referendum, energy generation market was set free, enabling the entry of private participants and a wholesale electricity market was created (MMEE).
Decree 360/002	Regulation of the Wholesale Electricity Market
Decree 77/006	Is entrusted to UTE the execution of electric energy trading contracts with biomass, wind or small hydro plants as source.
Decree 403/009	Public competitive bidding for wind energy
Decree 159/2011	Public competitive bidding for wind energy
Decree 424/011	Public competitive bidding for wind energy
Decree 367/2010	Is entrusted to UTE the execution of electric energy trading contracts with biomass as source.
Decree 133/2013	Celebrating special contracts for the sale of electricity between UTE and suppliers that produce electricity from solar photovoltaic power in the country it is promoted.
Decree 173/2010	Decree No. 173/010 authorizes subscribers connected to the low voltage distribution network to install renewable energy generation systems using sources such as wind, solar, biomass or micro hydro. This energy can be used by the generator or transferred to the grid. The modality is a Net- metering contract.
Decree 18,195	Biofuels Law (2007)
Decree 18,585	Promotion of Solar Power. Declares of national interest the use of solar thermal (2009)
Law 16,906	The Investment Promotion and Protection Law states that foreign investment is granted the same treatment as national ones, with no restrictions to capital repatriation or transfer of benefits, dividends and interests. (1998)
Decree 354/009	Within the framework of the Investment Law, Decree 354/009 declares the energetic industry as one of the specific promoted activities, which provides this industry with important tax exemptions.
Decree 428, 429 and 430 of 2009	Energy efficiency labeling
Law 18,597	Efficient use of energy (2009)
Decree 58/015	It's entrusted to UTE to make a competitive procedure to adjudicate a single special contract associated with a central to generate electric power produced from biomass in the country.

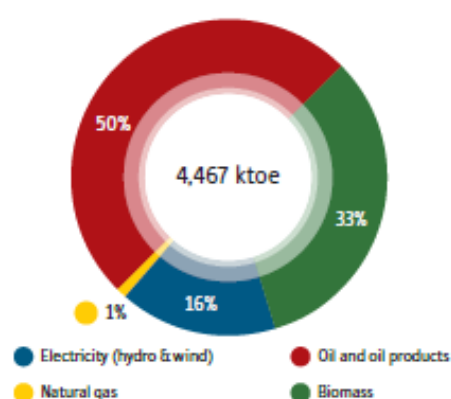
For other relevant rules for the sector, see <http://www.miem.gub.uy/web/energia>

3 ENERGY SUPPLY IN URUGUAY

3.1 ENERGY SUPPLY MATRIX

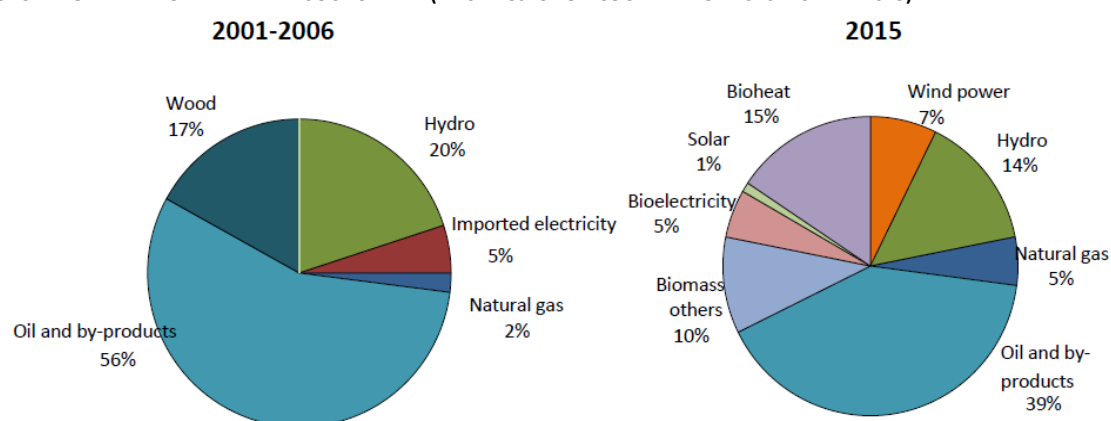
The main energetic sources of the energy supply matrix in Uruguay are oil and oil products, hydroelectric energy and biomass. Uruguay has an electricity supply of hydraulic origin that varies year to year, strongly dependent of the weather conditions. Below is presented the energy supply matrix by source in 2013.

CHART 2- ENERGY SUPPLY BY SOURCE.



Uruguay has gone through an extremely successful path in energy matters. The keys lie in the definition of a state policy in the long term (25 years) and an appropriate institutional and regulatory framework approved by all political parties. This enabled the design and realization of public-private partnership opportunities from which both sectors could benefit. The realization of these investments has resulted in a strong energetic matrix transformation process, which places Uruguay at the forefront in the use of renewable energies worldwide. As can be seen in the chart 3, in 2015 Uruguay will obtain more than half of its primary energy matrix from renewable sources.

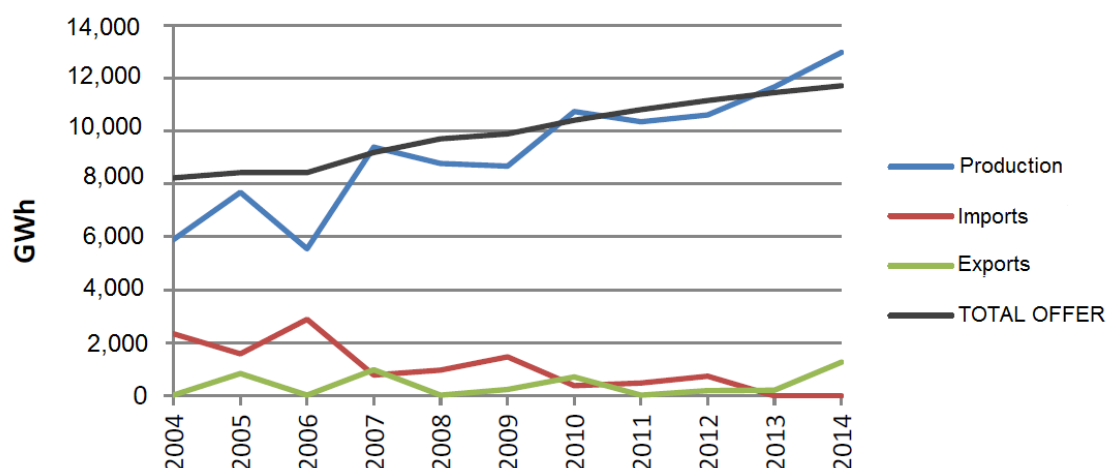
CHART 3- CHANGE IN NATIONAL MATRIX. SOURCE: DNE (THIS PROJECTION COULD BE FOR 2016 INSTEAD 2015)



3.2 ELECTRIC ENERGY SUPPLY

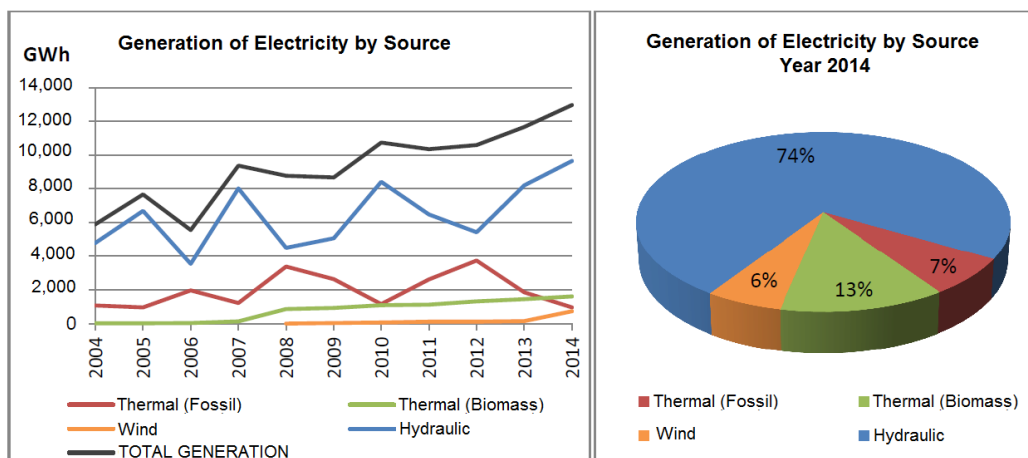
The total supply of electrical energy has presented a growing trend throughout the period 2004-2014 and was 11,702 GWh for the last year. To satisfy the country's demand, production is compensated by imports or exports, as the status and availability of supply from neighboring countries. In the years 2013 and 2014 there were no imports of electricity, a situation not seen for over 20 years.

CHART 4- ELECTRICITY SUPPLY BY ACTIVITY



As it was mentioned, the country has a policy for diversifying energy matrix, which has resulted in the incorporation of new local sources of electricity generation, among other measures. It is so, the share of wind energy and biomass as inputs for electricity generation is growing in recent years. In 2014, 93% of electricity was generated from renewable sources, while 7% was generated from fossil fuels.

CHART 5 AND CHART 6- ELECTRICITY GENERATION BY SOURCE



In addition, as it can be seen in Chart 9, in 2015 Uruguay will obtain more than 90% of its electric energy from renewable sources and it will turn into one of the countries with the largest share (28%) of wind energy in its matrix in the world.

CHART 7- CHANGE IN THE ELECTRIC MATRIX BETWEEN 2010 AND 2015. SOURCE: DNE (THIS PROJECTION COULD BE FOR 2016 INSTEAD OF 2015)

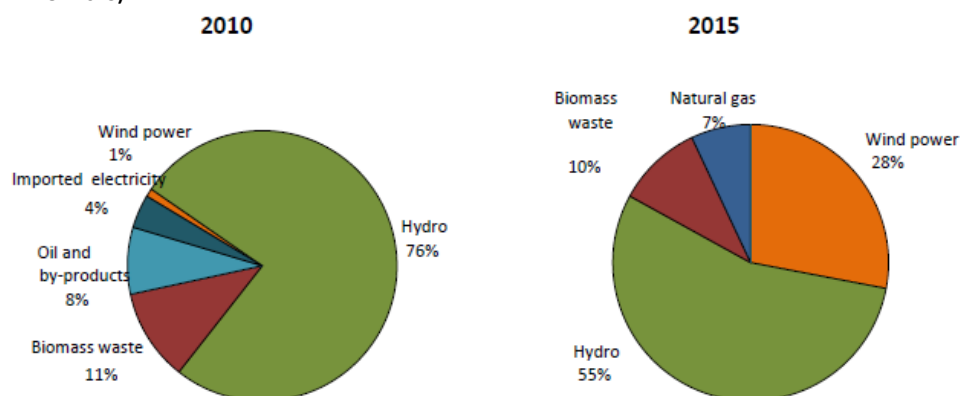
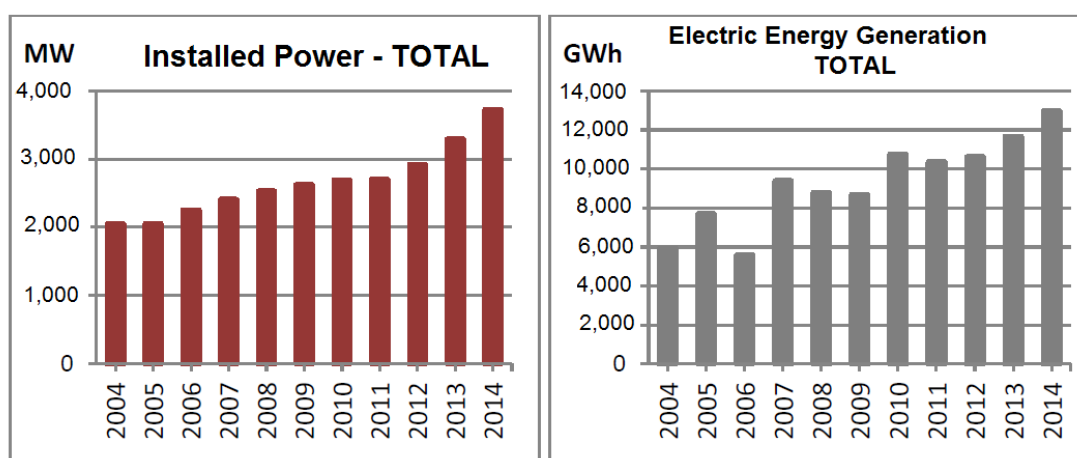


CHART 8 AND CHART 9- INSTALLED POWER AND ELECTRICITY GENERATION



4 RENEWABLE ENERGY BY SOURCE

4.1 HYDROELECTRICITY

Hydro generation is one of the main energy sources in Uruguay. The hydro generation in Uruguay is composed of three cascaded stations in Río Negro with a total of 593 MW (Gabriel Terra 152 MW, Baygorria 108 MW and Constitución 333 MW) and of a bi-national station in Río Uruguay (Salto Grande) of 1890 MW of which 940 MW correspond to Uruguay, the rest to Argentina. Currently, hydroelectricity use in Uruguay is near its maximum limit. Nevertheless, there is additional capacity for small hydro-power installations for self consumption and sale of surplus to UTE's grid.

4.2 SMALL HYDRO PLANTS (PCH)

For the purposes of developing PCHs in Uruguay, the Study to determine the most favorable points in the national territory to install small hydro plants (PCH) was introduced in 2014.

This study provides information to the different public and private institutions on PCHs and contains:

- 1 - Previous feasibility study and feasibility of PCH projects in Uruguay for:
 - Multi-purpose dams associated to irrigation and electricity generation (PCH).

They can be for already built dams for irrigation, by incorporating a PCH, or for new projects.

- Electricity generation exclusively (PCH).

2 - Energetic availability of a PCH.

3 - Environmental aspects of PCHs.

The complete report can be downloaded from the DNE's web site.

4.3 SOLAR ENERGY

Uruguay spreads across geographical latitude $30^{\circ} 04'$ and $34^{\circ} 53'$. Mean daily global radiation over Uruguayan territory is 4.4 kWh/m^2 (nearly the same as half of the electricity consumed by a unit family in Uruguay on a daily basis). There is large seasonal variation, with minimum values of 2 kWh/m^2 in winter and 7 kWh/m^2 in summer.

Territorial variation is less than seasonal variation, given the relative geographic uniformity of our territory. For instance, annual means register their minimum in Rocha (4.47 kWh/m^2) and maximum in the northern region, Artigas (4.81 kWh/m^2). The areas with the greatest solar radiation index are basically in the north.

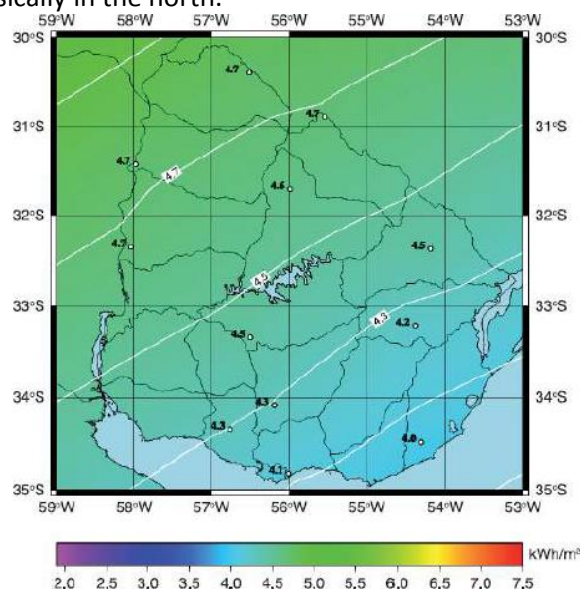


FIGURE 2-URUGUAYAN SOLAR MAP – MEAN DAILY SOLAR RADIATION (KWH/M²)

Solar thermal energy

In the case of solar thermal energy, a value of $10.7 \text{ m}^2/1,000$ inhabitants for efficiently operating installed area is obtained.

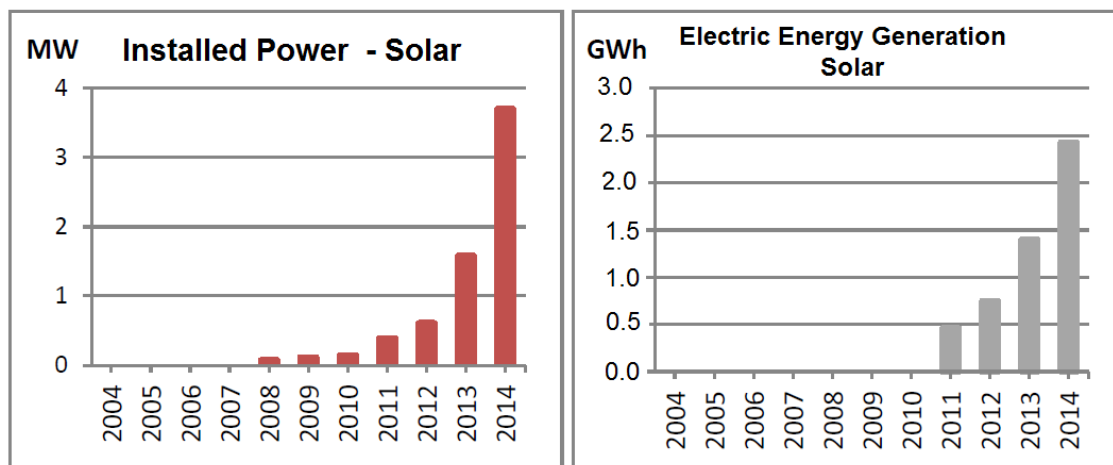
Uruguay also has organized a Solar Board (Mesa Solar), which is a cross-industry space for the promotion of solar thermal energy, through the creation of instruments which foster its development and coordinating actions among the players related to this issue. It is composed of public institutions, private companies, consultants and unions.

Solar photovoltaic energy

The solar photovoltaic energy is being developed and is taking part of the electric power generation matrix. Its participation in 2014 started being significant and in the next figure it is shown the evolution that solar photovoltaic energy has had in recent years.

There is a plant installed, the Japanese-Uruguayan company Asahi since 2013 with 0.5 MW of capacity.

CHART 10-INSTALLED POWER AND GENERATION OF ELECTRICITY – SOLAR PHOTOVOLTAIC (2004-2014)



With the Decree 133/2013 was promoted the celebration of special contracts for the sale of electricity between UTE and suppliers that produce electricity from solar photovoltaic power in the country. As result of this decree is expected the installation of approximately 200 MW of photovoltaic energy in the short term.

4.4 WIND ENERGY

Within the energy policy goals, it was defined to incorporate 300 MW of wind for 2015, with a revision in 2012 with the new goal of 1200 MW for 2015.

The Program for Wind Energy in Uruguay (PEEU), which has been an important background for the Energy Policy, was a joint initiative between the National Government and the Program for Developing United Nations (PNUD), carried out by the Ministry of Industry, Energy and Mining (MIEM), through the National Energy Board (DNE), and sponsored by the Global Environmental Facility (GEF). The PEEU started its activities in July 2007 and finished in 2013. This program had the target of creating a favourable scenario and promote the insertion process of wind energy in the country from a multidisciplinary approach, as a way of mitigating the emission of greenhouse gases.

The wind map made available by the Engineering School of University of the Republic can be used as reference, with different height estimation for up to 90 meters.

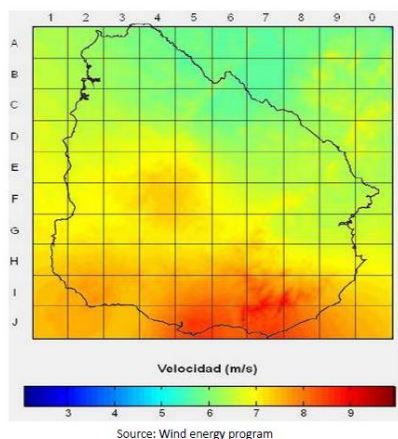


FIGURE 3-WIND MAP OF URUGUAY (HEIGHT: 90 M)

The large size wind energy has presented a significant development in recent years, especially in 2014, when were installed more than 400 MW and registered a rise in the electric power generation participation from 1% to 6% in just one year.

CHART 11-INSTALLED POWER AND GENERATION OF ELECTRICITY – WIND ENERGY (2004-2014)

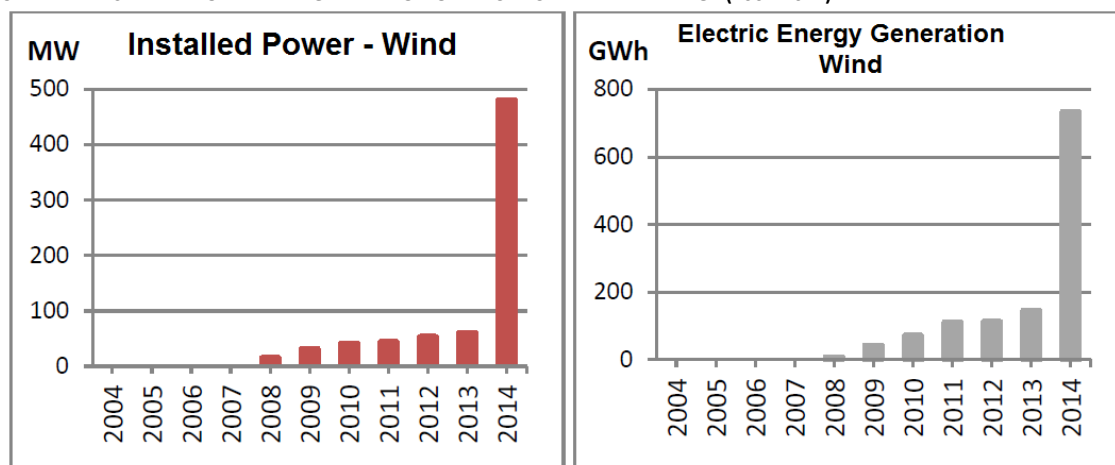
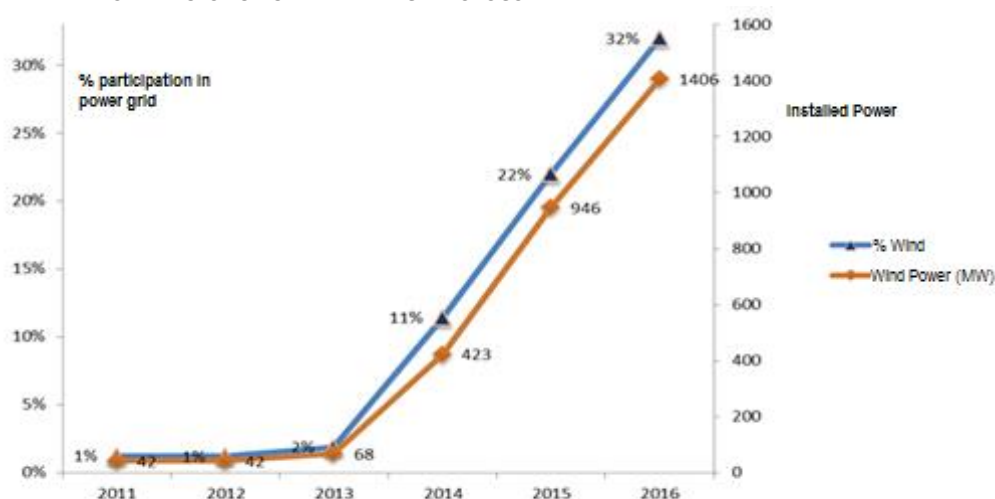


CHART 12- EXPECTED EVOLUTION OF WIND ENERGY IN URUGUAY



As it was mentioned, in 2015 Uruguay will obtain more than 90% of its electric energy from renewable sources and it will turn into one of the countries with the largest share (28%) of wind energy in its matrix in the world.

These are important calls done or modalities that have been utilized for the incorporation of wind energy:

Call 2010 (Decree 403/009)
 Call 2011 (Decree 159/011)
 Call 2011 (Decree 424/011)
 Industrial wind (Decree 158/012)
 Operative leasing 2012 (UTE Call K44875)
 Contracting of own parks UTE
 More information can be found in the DNE website.

Wind Projects

TABLE 5- WIND PROJECTS IN OPERATION

Proyectos operativos				Actualización: 11/08/2015
Convoc	Empresa	Pot autorizada (MW)	Departamento	Entrada operación
-	Agroland	3	Maldonado	mar-07
77/006	Nuevo Manantial	18	Rocha	jun-08
-	Caracoles I (UTE)	10	Maldonado	dic-08
-	Caracoles II (UTE)	10	Maldonado	jun-10
77/006	Kentilux	17,2	San José	may-11
-	Engraw	3,6	Florida	ene-13
-	Blengio	1,8	San José	jul-13
424/011	R del sur	50	Maldonado	abr-14
403/009	Palmatir	50	Tacuarembó	may-14
-	Togely s.a. - Libertad	7,7	San José	jul-14
159/011	Luz de río	50	Florida, Flores	ago-14
77/006	Luz de mar	18	Florida	ago-14
159/011	Gemsa	42	Lavalleja	set-14
77/006	Luz de loma	20	Florida	nov-14
424/011	Polesine	50	Florida	nov-14
UTE	Artilleros (UTE-Elektrobras)	65,1	Colonia	dic-14
UTE	Juan Pablo Terra (UTE)	67,2	Artigas	dic-14
424/011	Cadonal	50	Flores	feb-15
424/011	Astidey	50	Flores	jul-15*
159/011	Agua leguas	117,5	Tacuarembó	jul-15*
		701		

TABLE 6- PRIVATE WIND PROJECTS UNDER CONSTRUCTION

Proyectos en construcción - privados				Actualización: 11/08/2015
Convoc	Empresa	Parque	Pot instalada(MW)	Departamento
403/009	Fingano	Carapé	50	Maldonado
424/011	Estrellada	Melowind	50	Cerro Largo
424/011	Molino de rosas	Molino de rosas 50 MW	50	Maldonado
424/011	Libertador II (ex Noukar)	Libertador IV	50	Lavalleja
424/011	Vientos de pastorel	Nuevo pastorel I	49,2	Flores
424/011	Grupo Cobra (ex Tullifox)	Kiyú	48,6	San José
424/011	Vengano	Carapé II	40	Maldonado
424/011	Ladaner	Cerro Grande	58,5	Cerro Largo
Total			396	

TABLE 7- UTE PROJECTS UNDER CONSTRUCTION

Proyectos en construcción - UTE				Actualización: 11/08/2015
Convoc	Empresa	Parque	Pot instalada(MW)	Departamento
UTE	UTE	Colonia Arias	70	Florida, Flores
UTE	UTE	Valentines	70	Treinta y Tres
UTE	UTE	Pampa	140	Tacuarembó
UTE	UTE	Andresito	50	Flores
Leasing	Teyma	Palomas	71	Salto
Total			401	

4.5 BIOENERGY

4.5.1 Biofuels

In 2007, in Uruguay was promulgated the biofuels Act 18,195, its aim is to promote and regulate the production, marketing and use of biofuels, these being defined as all renewable liquid fuel from agricultural or agroindustrial origin, comprising among others, fuel ethanol and biodiesel.

The most important objectives of the law are:

- The promotion of the production of biofuels from national raw materials.
- Set goals for incorporating biofuels.

Alcohol is set to target a 5% addition to gasoline for vehicular use in 2015.

For biodiesel, is authorized to incorporate up to 2% of biodiesel to vehicular diesel until 2008.

In the period from 2009 to 2011, the incorporation of 2% is set mandatory and is compulsory from 2012 to mix 5% of biodiesel in diesel.

- the market for small and large scale is defined.

Small scale production is for consumption and captive fleets with previous authorization (for biodiesel only).

Large-scale production is for export and / or market with ANCAP.

- criteria for the production promotion and tax exemptions are set.

The result of the regulation of Law 18,195 was the Decree No. 523/2008, which was drafted in conjunction with representatives of the institutions directly involved.

In the decree it was decided to regulate those aspects that were considered priority as linked to the authorization of production, quality and marketing of biofuels.

After the regulatory decree, it was approved the URSEA Regulations for quality control, where responsibilities and procedures relating to quality control of biodiesel and alcohol fuel are defined.

With respect to technical regulations, a quality standard for Biodiesel, the UNIT 1100: 2005 and updates, was approved. Biodiesel (B100) – "Fuel for mixture with petroleum medium distillates". The compliance of this standard is established in Law 18.195.

In addition there are two standards for alcohol established in the decree of the law that are UNIT 1122: 2007 and updates "anhydrous ethyl alcohol fuel requirements" and UNIT 1124: 2007 and updates "Hydrated ethyl alcohol fuel. Requirements".

ALUR biodiesel and ethanol plants

The state-private company, Alcoholes del Uruguay (ALUR), has four main biofuel plants. Two for ethanol production and two for biodiesel production.

The installed capacity is:
 Total: 72,000 ton/year of biodiesel.
 Total: 95,000 m³/year of anhydrous ethanol.

Raw material used for biodiesel production_ soybean, sunflower, canola, tallow, vegetable oils recycled

Raw material used for anhydrous ethanol production_ sugar cane, sweet sorghum, grain sorghum, wheat, corn, barley

Recently ALUR has also a micro plant for the ethanol production from sweet potato, rice and sorghum of 1,000 L/day.

Nowadays, the gasoline in Uruguay has a 10% of ethanol and the diesel has a 7 % of biodiesel. The limits for the mixture were established by the URSEA. ALUR is carrying experiences to test higher concentrations of biofuels in vehicles and their impact in the engines, in these experiences are also participating DNE and URSEA.

4.5.2 Biomass

Uruguay has abundant biomass resources linked to the strength of the agriculture, livestock and forestry sectors.

Since the late 80's was promoted afforestation in Uruguay, allowing a major expansion of the sector. Uruguay currently forested area represents 5,6 % of the total land area, with 990.000 hectares planted.

Wood obtained basically has two industrial destinations: the forestry- industry and the production of pulp for paper. In both activities-products of industrial processes (sawdust, coastal, black liquor, etc.) can be used as fuel for power generation.

In table 5 it can be seen the operations plants in Uruguay that use biomass to generate energy, two that produces energy from biogas are included.

TABLE 7- OPERATION PLANTS PRODUCING ENERGY FROM BIOMASS IN URUGUAY.

Enterprise	Installed Power (MW)	Raw material	Departament
Celulosa y Energía Punta Pereira S.A. Montes del Plata	170	Black liquor	Colonia
UPM	161	Black liquor	Río Negro
Galofer S.A.	14	Rice husk	Treinta y Tres
Weyerhaeuser Productos S.A. Los Piques	12	Forestal	Tacuarembó
Bioener S.A.	12	Forestal	Rivera
Alur S.A. Bella Unión	10	Sugar cane bagasse	Artigas
Fenirol S.A.	10	Rice husk - forestal	Tacuarembó
Ponlar S.A.	7.5	Forestal	Rivera
Liderdat S.A. Azucarlito	5	Forestal	Paysandú
Fanapel	11.5	Black liquor	Colonia
Intendencia de Maldonado - Relleno Las Rosas	1.2	Biogas	Maldonado
Lanas Trinidad S.A.	0.6	Biogas	Flores

Total installed	414.8	Contract with UTE – 162.9 MW
-----------------	-------	------------------------------

PROBIO Project

The project “Production of electricity from biomass in Uruguay (PROBIO)” was a joint initiative of the National Government with the United Nations Development Programme (UNDP). It was implemented by the Ministry of Housing, Spatial Planning and Environment (MVOTMA), through the National Directorate of Environment (DINAMA); the Ministry of Industry, Energy and Mining (MIEM), through the Department of Energy (DNE) and the Ministry of Livestock, Agriculture and Fisheries (MGAP), through the Department of Forestry (DGF). The project was funded by the Global Environment Facility (GEF).

The aim of the project was to develop the instruments of access to information, incentives for the development of local capacities, design and proposed instruments for energy, environmental policy and use of natural resources to promote sustainable energy use of biomass products from forestry and other chains.

The project ended in 2014, for further information and to access to the products of the project, refer to: <http://www.probio.gub.uy/>

4.5.3 Biogas

Examples of biogas plants in the country

In Uruguay there are two plants in operation and giving energy to de grid from biogas: Las Rosas landfill and Lanús Trinidad (producer and exporter of combed wool tops) and other plants with an advanced grade of construction.

Las Rosas Landfill

Las Rosas landfill is located in the department of Maldonado, at the southeast region of Uruguay.

The project aims to demonstrate self-sustaining modern waste management of municipal solid waste through maximum collection of generated methane, thereby reducing greenhouse gas emissions and creating a revenue stream to cover capital costs and operational costs, according to information from the World Bank's Global Environmental Facility (GEF).

The waste used at this landfill is domestic and the approximate waste composition is 70 % organic, and this organic matter is 57% high degradation rate, 10% medium degradation rate and a 3% low degradation rate. The approximate waste disposed per year is about 50,000 ton. The waste disposed is not separated nor classified.

The plant generates 1MW and supplies power, in its first stage, to some 2,500 homes in San Carlos and Pinares on the coast of Maldonado. It is estimated that it will generate until 2022 5,800 MWh per year. The average depth is 13 m and the area covered is 8.14 Ha.



FIGURE 4- LAS ROSAS LANDFILL

Twenty wells have been drilled at the site, where methane gas is captured and stored in tanks. The GEF donated US\$975,200 of the project costs. The Maldonado municipality also contributed US\$334,800, Aborgama-Ducelit provided US\$100,000 and Uruguay's environment ministry gave US\$60,000.

Lanas Trinidad

Lanas Trinidad is the main producer and exporter of combed wool tops in Uruguay. Its annual sales are over 50 million dollars and its products are exported to the most important and demanding markets in the world.

Lanas Trinidad owns 140 hectares of land; all effluents with biodegradable organic substances are anaerobically and aerobically treated, once the wool grease has been extracted. Recently Lanas Trinidad, has changed the extensive treatment of anaerobic reservoirs for a compact and more efficient system to obtain biogas. Therefore, greenhouse gas emissions have been reduced by 95% and biogas is used as a renewable energy source.

Water self-supply and effluent treatment has involved an investment of over US\$ 9 million. Lanas Trinidad can produce 600 kW of energy that is given to the grid and the heat from the engines is used to maintain the wastewater treatment temperature.



FIGURE 5- LANAS TRINIDAD WASTEWATER TRATMENT AND POWER GENERATION FROM BIOGAS PRODUCTION

Estancias del Lago (under construction)

Estancias del Lago located in Durazno department, produces powdered milk and has its own milking cows and milking yards. The company also produces vegetable oil and expeller for animal food from soybean crushing.

The plant has an anaerobic digestion system to co-digest cow manure with other types of organic waste streams: cow manure, animal food residues (soybean, corn), glycerol from the biodiesel plant (not yet), wastewater from the powdered milk production plant, waste from surrounding industries (still to be analysed if feasible) and organic domestic waste from Durazno City (still to be analysed if feasible).

The anaerobic treatment includes several mesophilic complete mix reactors (diameter: 30 m, height: 10 m, temperature: 35°C) to be constructed in stages, as the population of cows is expected to increase from 3,000 to 9,000 in 2015 and other wastes are also to be included.

Some reactors are already constructed and soon the plant will be producing energy.

A process flow diagram of the treatment is shown below.

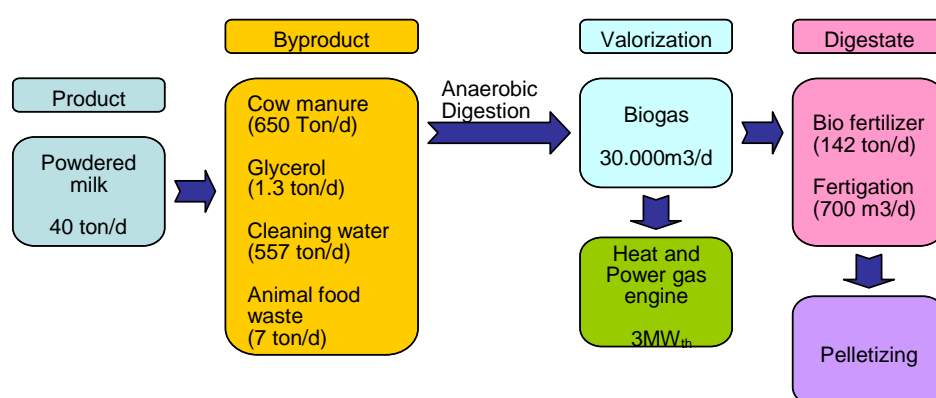


FIGURE 6- SCHEME OF THE WASTEWATER (MIX OF DIFFERENT SOURCES) TREATMENT SYSTEM AT ESTANCIAS DEL LAGO



FIGURE 7- BARN AND BIODIGESTORS FOR WASTE TREATMENT

Colonia Delta

The community Colonia Delta, located in the west of the Department of San José, Uruguay, has been chosen for the installation of a biogas micro generation system. Using the manure from its main cattle raising and dairy industry, the waste will be used to produce heat and electricity through a biogas system.

The Global Sustainable Electricity Partnership will work together with the United Nations Development Programme (UNDP) in the development of the project. The project is led by member company Eletrobras and, as the project's technical consultant, its subsidiary Itaipu Binacional (through the International Center for Renewable Energy – Biogas CIBiogás–ER). The pilot Project in the Department of San Jose will have very similar features as the Ajuricaba's project, in Marechal Cândido Rondon (Brazil). The GSEP project will be the first phase of a total of three.

The project proposal is to treat the effluent of 22 properties by upflow digesters deployment and production of biogas. It is estimated that the properties generate daily 46.64 cubic meters of waste and produce daily 763.81 m³ of biogas. The biogas produced will be transported through a rural low-pressure pipeline and will be utilized to generate electricity by means of a motor generator of 75 kVA providing 1527.62 kWh / day of energy.

Biogas Committee Uruguay- UNIT

UNIT (Uruguayan Institute of Technical Standards) is the representative institution of ISO en Uruguay. On demand of the DNE, was established a specialized committee in biogas in UNIT. The Committee has 41 delegates representatives from 28 institutions.

Background search at regional and international level was conducted and the following topics were defined as interest of the Committee for the development of standards:

- Treated Biogas. Quality and safety requirements of the product according to the use.
- Safety equipment installations of biogas plants and transporting systems including aspects of safety in design, construction, operation and maintenance of the facilities required for the transport and consumption of biogas from production to final consumption.

According to the prospects for use of biogas in Uruguay, is not interest the normalization of biomethane, because it is not projecting its injection into the grid or as vehicle fuel in the short term.

The Committee in Uruguay entered to the ISO / TC 255 Committee as an observer member, at this time the Committee follows the progress of the ISO Committee.

Scientific research in anaerobic digestion

In Uruguay, scientific research related with anaerobic digestion and biogas production is centralized in the Reactor's Department from the Chemical Engineer Institute at the Engineering Faculty of the national university Udelar (<http://www.fing.edu.uy/iiq/IIQ.html>). This institute works in permanent collaboration with the Microbiology Group from the Institute of Biological Research Clemente Estable (<http://iibce.edu.uy>) and with the Fertility Soil Group from the Agronomy Faculty (Udelar) (<http://www.fagro.edu.uy/~fertilidad>) conforming the BIOPROA group.

The BIOPROA group has more than 20 years of experience in the seek of new environmental solutions for the solid and liquid wastes treatment. This group carries out fundamental research in biological processes and reactor's design as a basis for the development of new technologies that could be applied y commercialized by companies specialized in this matter and also by the industry in general. In particular, it seeks to promote the development of this type of companies in Uruguay. The addressed problems are of biological kind, in order to remove organic matter, minimizing the power consumption and also generating power if possible.

The BIOPROA laboratory's pilot plants have been installed and operated with different purposes such as research, developing and attending to the private sector needs. Four pilot plants and other four real scale plants have been designed and built.

In the Reactor's Department there are two main research streams, basic and applied research.

There are four lines of research:

- Design of reactors for liquid waste treatment
- Design of reactors for solid waste treatment
- Fluid dynamics, kinetic and transport phenomena inner and extra particle modelling
- Energy production (CH_4 , H_2)

In regard of waste treatment, the research and development in biological waste treatment is focused in four concepts:

- Minimize energy consumption
- Produce renewable energy
- Reduce greenhouse gas emissions
- Produce stabilized sludge that can be used for fertilizer

Basic Research

The main topics in basic research are:

- Study of phenomena involved in biological process: mass transfer, kinetic and hydraulic phenomena
- Hydrodynamic characterization of different type of biological anaerobic reactors of high and medium load.
- Biological hydrogen production by dark fermentation of carbohydrates: study of factors involved in raising the production, fermentation routes, kinetic determinations, evaluation of different reactor's designs.
- Biological removal of nitrogen, removal by nitrite, study in different carbon sources, kinetics determinations.
- Study in the influence of the flux model in the anaerobic degradation of solid waste
- Rate determining step identification in the degradation of high fat content effluents.
- Biological reactors modelling

Applied research

Concerning applied research, these are the most important works related with the industry in Uruguay:

- Critical aspects analysis in the design and operation of real scale reactors for high fat content effluent treatment (dairy wastewater) and high organic matter content effluents (whey and alcoholic wine)
- Physical, chemical and microbiologic parameters correlation during a real scale reactor operation.
- Study in different set ups for solid waste treatment (e.g. rumen)
- Complete system in real scale for effluent treatment with organic matter and nutrients removal.
- Global balance for systems of waste treatment considering the use of by-products and minimizing the residues generation.

4.5.4 Biovalor Project

Since November 2013 Uruguay has a cooperation project in place: "Towards a green economy in Uruguay: promoting Sustainable production practices and technology with low emissions in the prioritized sectors", Global Environment Facility (GEF), which will last 4 years. The main objective of the project is the transformation of waste generated from agricultural and agro-industrial activities and from small populated centers into energy and/or byproducts, for the purposes of developing a sustainable low emission model (contributing to the reduction of the Greenhouse Effect - GEI) through the development and transfer of the appropriate technologies. In first place, this project intends to analyze the reality of every agro-industrial chain in the country as well as the existing technologies for treating the corresponding waste. Then, pilot plants will be financed and a map road will be drafted in order to reproduce the successful cases.

It is implemented by the Ministry of Housing, Spatial Planning and Environment (MVOTMA), through the National Directorate of Environment (DINAMA); the Ministry of Industry, Energy and Mining (MIEM), through the Department of Energy (DNE) and the Ministry of Livestock, Agriculture and Fisheries (MGAP) and the United Nations Industrial Development Organization (UNIDO) as implementing agency. The project was funded by the Global Environment Facility (GEF).

Funds: Co-financing Global Environment Facility - GEF
Donation amount: 3,392,727 dollars

Co-financing: ALUR S.A., Instituto Nacional de Colonización (INC), Estancias del Lago, MIEM, MVOTMA, MGAP, UNIDO (Public and private organizations)
Co-financing amount: 32,410,000 dollars

The project has four components (PC):

1- Policy and regulatory framework strengthening

The activities to be undertaken under PC1 are intended to adjust the regulatory and policy frameworks in order to promote investments and allow the development of waste valorisation projects to generate energy, by-products and reduce GHG emissions. These activities also involve the removal of financial barriers and the development and implementation of policies, provisions and guidelines for financial instrument(s) that will lead to the deployment of waste valorisation projects in Uruguay.

2- To strength knowledge base (technological capacities) in the fields of waste-to-energy, waste valorisation and low emission waste treatment technologies.

Physical and chemical characterization of waste streams with valorisation potential and prefeasibility studies (including social, environmental and economic dimensions) conducted in the targeted sectors to determine the most viable waste valorisation processes and business models.

3- Demonstration of waste valorisation and renewable energy technologies' applications

This component aims to design, install, monitor and assess small- as well as large-scale demonstration projects in the targeted sectors. This component complements the previous component and it is intended for demonstrating the applicability of more technologically advanced waste treatment techniques, in comparison to the current "first generation" technologies that are employed in the country at the moment.

3.1. This component includes the following and cooperation with the:

- Implementation of a project in the agro-industrial, bioethanol production sector: ALUR S.A.
- Implementation of a project in the dairy sector: biogas generation from cow manure anaerobic treatment at FAROLUR S.A.
- Implementation of a project in the agro-industrial sector: energy generation with biogas from production processes wastes at Estancias del Lago.
- Implementation of a centralized waste valorisation facility as a project in the agricultural sector: Instituto Nacional de Colonización (INC)

The four large-scale projects described previously will provide valuable experience and lessons learnt with respect to the installation, operation and monitoring of waste valorization technologies.

3.2. It will be made a call for Proposals for and implementation of at least five small to medium scale projects, including (i) design of the call; (ii) feasibility and technical design studies for demonstrations in medium and small sized farms / industries in the targeted sectors; and (iii) implementation of at least five full-scale projects in medium and small sized agro-industries.

The Call is to be hosted by the three ministries involved. A minimum of two calls are planned to take place during the duration of the project, with the first one targeting all prioritised technologies, while the second one will focus on those technologies that did not generate sufficient interest the first time.

The selected pilot projects will not be fully funded through the Project but will require a self-commitment of up to 20%.

- 4- Capacity building, training and dissemination campaign for the adoption of low carbon waste valorisation initiatives

4.5.5 Other activities in the bioenergy area

- FAO – DNE – Faculty of agronomy (University of the Republic)

Analysis and identification of relevant sustainability indicators defined by GBEP (Global Bioenergy Partnership) for energy production chains based on forest biomass residues and biodiesel and bioethanol chains.

- ALUR- DNE- CIEMAT

Analysis of the socioeconomic impacts of the alcohol production chain from sugarcane and carbon footprint.

- Now is starting a new project "Economic social externalities, and carbon footprint of biofuels production in Uruguay" to include the rest of ethanol chains and biodiesel. This project will be executed between ALUR, DNE and with funds of the National Agency for Research and Innovation. (The National Agency for Research and Innovation or ANII is the main national funding agency in Uruguay and has a Fund for specific Energy projects: Sectorial Fund for Energy financed by UTE, ANCAP and DNE).
- Participation in the Mercosur ADHOC group of biofuels.

5 REFERENCES

- DNE site_ www.dne.gub.uy. Solar energy, wind energy, Bioenergy in Uruguay, Biovalor project, Regulatory framework.
- Preliminary energy Balance 2014. National Board of Energy Planning, Statistics and Balance

- Energy Balance 2013. National Board of Energy Planning, Statistics and Balance
- Energy Balance 2013 Brochure. National Board of Energy Planning, Statistics and Balance
- Uruguay en cifras 2014. Instituto Nacional de Estadística (INE). www.ine.gub.uy
- FAOSTAT Country Profiles.
http://faostat.fao.org/CountryProfiles/Country_Profile/Direct.aspx?lang=en&area=234
- Human Development Report. HDI values and rank changes in the 2014 Human Development Report – Uruguay.
<http://www.who.int/countries/ury/en/>
- Renewable energy. August, 2014 Investment opportunities –Uruguay XXI. Investment and export promotion agency
- GSEP site - <http://www.globalelectricity.org/en/index.jsp?p=121&f=382>
- CI Biogas site- <https://cibiogas.org/San%20Jose/Uruguai>
- Lanas Trinidad site- <http://lanastrinidad.com/>
- Implementation Completion Memorandum (ICM) 39212 – WorldBank. http://www-wds.worldbank.org/external/default/WDSP/IB/2007/03/28/000020439_20070328104634/Rendered/PDF/392120UY0Metha1ICM0P05830301PUBLIC1.pdf
- <http://siteresources.worldbank.org/INTUSWM/Resources/463617-1185383612643/Zamonsky.pdf>
- Hydrocarbons exploration. New onshore and offshore exploration activities have located Uruguay in the world's oil map. August, 2014 Uruguay XXI. Investment and export promotion agency

