ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 9, March 2013

Innovative Methodology to Use Renewable Energy for Engineering Learning Application

MSc. Carlos Labriola, Eng. Isabel Ferraris, Dr. Jorge Lassig, Lic. Caludia Palese

Abstract*— This work is based on a methodology to develop and optimize Renewable Energy (RE) applications in Neuquén Province, Argentina. The first stage is to determine the location of RE project and then select the sources which are relevant in energy production. With this information, RE converters conceptual design is made. Then, the proper converter is chosen with the calculated power module and preliminary unit commitment according to the energy demand. The alternative with less environmental, health impact and most social and economical impact analyzing the life Cycle of the Power plant is chosen. Holistical Methodology is used for managing the project and avoided CO_2 is calculated by means of Clean Development Mechanism. Green Bonus can be offered when the Power station will begin in operation. The example presented in this work is the Power Station as Renewable Energy School Application (RESPS) in Engineering Faculty, National University of Comahue (EFUNCo), Argentina. Research Groups (RG) of EFUNCo are developing this kind of project including students as volunteers for design, manufacturing, installation and maintenance of Wind, Micro-Hydro, Biomass and Solar devices for several kind of Social and Energy applications in Patagonia. These RG decide on 2010 to work together, forming a Centre of Renewable Energy Sources Analysis to develop the RESPS and other RE projects.

***Index Terms*— CO_2 avoided, Holistically Method, Renewable Energy, School Power Station.**

I. INTRODUCTION

Neuquén Province is in the Comahue Region in the North West of Patagonia as shown in Fig. 1. In this region, where RGs of EFUNCo are working on RE Applications, have all the Renewable Energy sources except Marine Currents and Tidal Energy. It has Solar Energy as Puna on the North of Argentina during summer, Wind energy particularly during spring and summer, consequently Wave energy on artificial and natural lakes, Biomass from farming activities and food industries, Big, Medium and Micro Hydro and finally Geothermal Energy near Los Andes Mountain Range [1]. Particularly in Neuquén City, the available RES are Wind, Solar, Micro-Hydro and Biomass from farming and domestic waste. RG of EFUNCo propose to supply energy for whole University by means of a power station with RE fuels [2] not only as an energy supply, but also as school of green electrical generation. This project is carrying on Engineering Faculty where RGs are developing the different RE conversion systems. It can be seen in item III the pictures of them which are similar that are in manufacturing in EFUNCo.

II. METHODOLOGY

The Innovative Methodology includes the following stages:

A. Selection of Renewable Energy Source.
B. Holistic organization for managing the project.
C. Study of UNCo electrical demand and its variation during the year.
D. Defining the adequate and available technology for the Renewable Energy Converters.
E. Life Cycle analysis for RE converters and the whole power plant and it accessories (Control, communication, supervising system, etc).
F. Study of CO_2 emissions and avoided CO_2 emissions during the Life Cycle by means of Clean Development Mechanism.

A. Selection of Renewable Energy Source

The selection of RES as first step is made by observation of biological indicators on the place of project location.

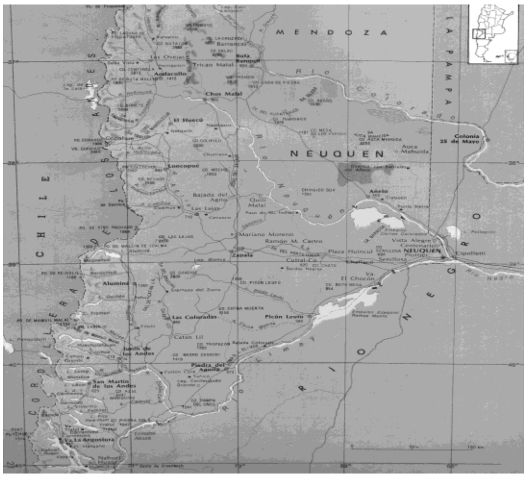

Fig 1: Comahue Region, Neuquén Province and Neuquén City

Then by evaluation of principal RE sources parameters by means of measuring with proper instruments in a micro scale analysis. In the case of wind energy, wind speed is measured at different heigts (at least 2) taking into account the surface roughness and direction. All this wind behavior information was made by means of micro scale study modeling of wind magnitudes [3]. Then the wind profile and the compass rose are made taking into account the energetic wind direction. The wind in Comahue Region is seasonal and it has a lot of gusts until 170km/h during the gale and wind direction change during the gust 70% of times. In the case of Solar Energy, Radiation in kW/m^2 is measured for horizontal flat plate and it is similar to North of Argentina (Puna) from October to

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 9, March 2013

March. In the case of Micro-Hydro application head height between reservoir and turbine is measured. Also the availability of water in the pond in m^3 is measured for Micro-Hydro turbine. In the case of Biomass, waste mass from University dining room in appropiate water dissolution is considered to obtain biogas [4] and fat production of microalgae with later esterification is taking into account to produce biodiesel [5].

B. Holistic organization for managing and risk assessment on the project.

A Holon is a process that is itself a whole and at the same time is part of a more general process. *This should not be understood that part is somewhat fragmented and incomplete but that in itself is a "whole" that simultaneously include a broader process which is a part* [6]. The holistic approach is represented by a hierarchical tree in which higher levels Holons represent conceptually broader and complex at the same time are less accurate as shown in Fig. 2. As one moves down the hierarchy, Holons are more specific, less complex and less conceptual content. This tool associated with a risk assessment conducted by an interdisciplinary group of experts which in our case would be responsible for performing each discipline in the project is very useful given the multidisciplinary project tasks or anticipating critical activities. (Electromechanical, wind, water, buildings, etc...) [7]. In the case of Risk Assessment we can say that the concept of risk is always associated with the future, with possibilities, with events that have not yet happened. *Risk is a natural consequence of the uncertainty inherent in all human activities.* Risk assessment involves complex issues. In principle, this is a multidisciplinary task where stakeholders influencing factors ranging from political to social and technical. When the risk is considered, engineers tend to focus on the analysis, evaluation and control of technical factors, the "hard" problem. The uncertainties associated with them are generally random. For its treatment exists methodologies to achieve important clarifications. It is generally based on established and proven protocols and tools used are based on formal mathematics biunivocal (or deterministic methods based on probability theory). In the case of "soft" problem, it is related with non-technical factors, and they are more difficult for analysis. The uncertainties associated with them are called epistemic for modeling which are not suitable for the same tools those technical factors. For evaluation, it is usual to ask to expert opinion, which base their judgments on objective and subjective, the latter based on his experience and professional capacity. In this work the experts are the researchers and their assistants of the RGs of EFUNCo involved in the project.

C. Study of UNCo electrical demand and its variation during the year.

Initially it was studied the EFUNCo demand which has two magnitudes to consider: the availability of power (kW) asked to utility company and the energy (kWh) consumed [8]. Later EFUNCo demand is compared with other Faculties and we could verify that they have the same variation than EFUNCo during the year and the maximum power required by whole UNCo is 1.165 MW. With all these data, we define an installed power of the power station as 1,165MW. It permits to supply the present required power and not more because in Argentina energy users can not sell energy to the Distribution Electrical Company because of there is no any regulation already for this kind of market. The increase of demand in the future will be supply by spinning reserve on Thermal generation.

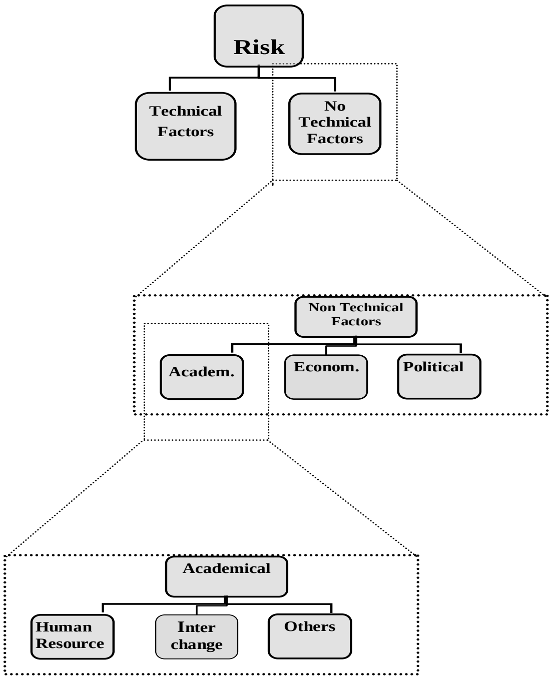

Fig 2: Hierarchical Tree of Holons in Different Levels of Decision [7].

D. Defining the adequate technology for the Renewable Energy Converters.

Taking into account the RES and its quality in power station location and the available technology in the Comahue Region, technology of RE converters is defined as: Wind turbine: Darrieus-Troposkien Vertical Axis Turbine (DTVAWT) is chosen because it is Omni directional, indifferent for gusts and its direction changing, consequently it don't need orientation control system. It is not necessary big cranes a wide roads to transport, installation or maintenance up to 40m high ,because has the bulk part at soil level. Also the easy blade geometry (NACA 00XX) facilitates its construction. Consequently a lower cost of manufacturing, installation and maintenance than Horizontal Axis Turbines (HAT) is expected [9]. Micro-Hydro: A Turgo turbine is chosen because primarily it will be used for teaching Hydraulic Machines and can be used in action or reaction application with not very high head height (20m) [10]. PV System: it is used for distributed lighting because PV panels are very expensive in local market and there are no green loans to buy it in Argentina [11]. Biomass: biogas obtained from anaerobic digester using organic matter from university dinning room will be one of the RE fuels [4]. The other is biodiesel obtained by esterification from fat of microalgae cultivation [5].

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 9, March 2013

E. Life Cycle analysis for the Converter and the whole power plant and it accessories (Control, communication, supervising system, etc).

Life Cycle analysis is based on the study made by Vestas and Nuon Company in Denmark [12]. They defined for each period (design, manufacturing, installation, operation, disassembling and recycling) the equivalent energy demand depending not only for the kind of tasks but also for the different materials used [13]. This methodology is named Energy Balance Method.

F. Study of CO_2 emissions and avoided CO_2 emissions during the Life Cycle by means of Clean Development Mechanism.

Kyoto Protocol sets three flexible mechanisms, where the main objective is to offer those interested in reducing emissions, at lower cost. These mechanisms are: Emissions Trading, Joint Implementation and the Clean Development Mechanism (CDM). In the case of small-scale projects different categories were established as shown in Table I. We can conclude from Table I that the project may be included in Category IA small-scale CDM and will follow the methodology of the Panel on Climate Change of the United Nations, (approved Small Scale Methodologies) Version 14 (PCC of UN, AMS, 2010) [14]. The next step of avoided CO2 calculation is to define the unit commitment of the different kind of ER generation [15]. The installation of it depends on the availability of design, technology and funds, so Table II describes the operation beginning of the four types of generation during the first four year of operation. The operation period is estimated in 25 years, so the next 21 years to the forth one, the estimated energy produced by RE power station will be at least 3.525 MWh/year. The baseline is determined by the fuel consumption of the technology used. Once determined the baseline year (Table II in kWh / year), emissions are calculated by multiplying them by the CO2 emission factor (EF) of displaced fuel [16]. An EF is a ratio between the quantity of pollutant emitted into the atmosphere and the power of the unit in operation. EF provides the amount in tones of CO2 equivalent that are achieved by reducing or avoiding each MWh generated, and it is the basis for the reduction of emissions of greenhouse gases (GHG) produced by the application of energy efficiency, renewable energy or cogeneration projects, which impact on the generation of electricity. Emission reductions are obtained from EF based on two coefficients which are Operating Margin (OM: it includes all plants that are in operation last year) and Build Margin (BM: it includes plants that have been installed in the last 3 years) [16]. These emission factors depend on the kind of machines coupled to the generators in the Electrical System of Argentina. The worst condition is taking into account which is with highest values of EF as shown in Table III.

Table I: Categories for Small Scale Projects

Category	Technology
I.A. Residential electricity generation	Renewable Energy Sources used for residential user.
I.B. Mechanical energy for users/companies	Renewable energy generation to supply mechanical energy for users and companies which need a little energy amount: mechanical, thermal or electrical one.
I.C. Thermal Energy for end user.	Thermal renewable energy supply replacing non renewable fossil or biomass (should no exceed 45 MW)
I.D. Electricity Generation with renewable sources to supply distribution grid	Renewable energy i)installations which supply electricity a distribution grid with at least one power station with fossil fuel, or non renewable biomass. (limits: eligible Renewable Power of 15MW – Cogeneration based on Biomass less than 45MWt)

Table II: Unit Commintment Depending On Renewable Energy Supply and Beginning Operation Year [15]

Power, Energy and RES		**Year 1**	**Year 2**	**Year 3**	**Year 4**
Peak Demand (kW)		400	600	1000	1350
Peak Power supply (kW)		295	535	875	1165
Energy Supply (kWh/ year)	**Micro - Hydro**	43.800	43.800	43.800	43.800
	Wind	402.998	435.030	1.165.700	1.56×10^6
	Biogas	397.902	847.963	1.065.598	1.44×10^6
	Bio-diesel	177.563	222.751	335.817	469.169
Energy purchased (kWh/year)		29.962	28.795	19.651	26.221
TOTAL ENERGY PRODUCED (KWH/YEAR)					**3.525.042**

Table III: Baseline Avoided Emissions for Different RES during CEERC Operation

RE Source	1st Year	2nd. Year	3rd. Year	4th Year
Micro Hydro turbines	22,29	22,29	22,29	22,29
Wind turb.	205,12	221,43	593,34	798,06
Biogas	190,22	405,38	509,43	690,41
Biodiesel	84,89	106,49	160,54	224,29
Avoided Emissions (t CO_2)	**502,53**	**755,59**	**1285,60**	**1735,05**

Table IV: CO_2 Emissions Estimation during the Life Cycle of CEECRC

Period	**Demand MWh**	**Worst Em.**	**t CO2 emited**

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 9, March 2013

		Factor	
Design	520,00	0,509	264,68
Manufacturing	1356,65	0,509	690,53
Maintenance	333,77	0,509	169,89
Dismantling	591,92	0,509	265,65
Recycling	-196,98	0,509	-95,17
	TOTAL		**1295,58**

Then CO_2 emissions can be calculated by means of Energy Balance method form VESTAS [12]. Table IV shows by means of the energy equivalent uses, the CO_2 emissions by EF from SEA. The negative figures in Table IV are related on the energy saved using recycled materials instead new ones. Taking into account 25 years of operation (first 3 years + 22 years with 1,165MW) the final results of CO_2 avoided are in Table V.

II. CONCEPTUAL DESIGN OF RENEWABLE ENERGY DEVICES

The conceptual design of renewable energy devices involved in this project, is based on Distributed Energy Supply, Smart Low Voltage Grid and replacing imported technology as the National Government Policies define. Some of these devices will be offered as free hardware for future replication. These RE Converters size and characteristics consist on:

- DTVAWT of 5kW (diameter 4m) and 50kW (diameter of 30m) [17] (Fig. 3), with extended performance to 30m/s of wind speed by means of Fiber Glass Reinforced Plastic rotor with aerodynamics brakes which also permits to start the operation. Aerodynamic brakes as a parallel profile on the blades will provide not only a braking system to maintain the rated power until 30m/s but also a start system, because Darrieus rotor cannot auto star with wind [9].
- Micro-Hydro Turgo Turbine (Fig. 4): It is of 5kW and it will be combined with DTVAWT of 5Kw [10] to operate when it is no wind. It is very easy to manufacture and has the advantage that can be used replacing a Pelton (Action turbine) or a Kaplan with fixed geometry (Reaction turbine), depending on the head height. In this application it will be used in both situations because practical work will be made with the students. The reservoir is a Tank of 100.000 l used for irrigation. The Turgo machine will be connected previously the irrigation grid, using a difference of level of 20m between the reservoir and the turbine location. The location of both, reservoir and turbine, are on two “tongues” of Plato near the UNCo buildings, which has that difference of heights.
- Biomass: Anaerobic Digester (Fig. 5) using Organic Waste (ADOW) from university dinning room will provide biogas to a spark engine with a 100kW generator. This third generation digester [20] permits different bacterial growing in each compartment, giving a dynamical grows equilibrium among bacterial colonies. Biodiesel from hydrolyzation of fat from microalgae will be used in a diesel engine with other 100kW generator.

Table V: Final Values of CO2 Avoided Emissions [15].

Total CO_2 avoided in 25 years of operation	Total CO_2 emissions during Life Cycle	CO_2 net emissions during life Cycle of CEECRC
44873,05	1295,58	43577,46
100%	3%	97%

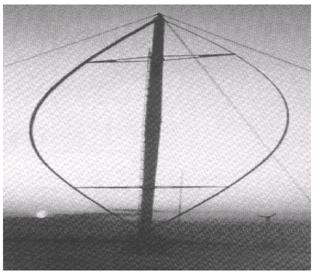

Fig 3: Darrieus Troposkien Wind Turbine [18].

Fig 4: Turgo Micro-Hydro Turbine (ITDG, 1998) [19].

- PV systems: PV panel and high power LED (Fig. 6) are chosen for this application [11], which are easy to obtain in the market. RGs test the devices offered by manufacturers in Argentina. This PV application can be combined with other RES as wind energy. These Panels for distributed lighting in isolated areas in de UNCo campus provide light for the paths needed in thematic parks.

Initially the demand supplied will be EFUNCo (wind-Micro hydro 55kW- Thermal biomass 200kW) and then two 700kW of thermal generation of energy by means of biomass products will be added. To supply the rest of UNCo. Also procedures for Training for installation, maintenance, manufacturing and recycling are included in the design reducing energy uses, environmental impact and CO_2 emissions. These procedures can be used by future users when these devices will be replicated for a particular application energy supply as people in isolated places. In Patagonia and all along the Los Andes Mountain range where are 4 million inhabitants in this condition [21].

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 9, March 2013

III. PROBLEMS TO CARRY ON THE PROJECT

The actions described in the holistic analysis (item II.B) are classified in technical aspects and non technical aspects. Technical aspect actions have relatively no problems to carry on, because they are made under technical regulations and standards. But in the case of nontechnical aspect actions, they are involved in bureaucracy situations, where sometimes there are people not qualified in technical skills that have to decide on feasibility of the projects. Particularly the situation to ask places to locate the different machines in the UNCo Campus, took 17 months of notes and meetings with people of different levels in executive positions in the University Staff. Also the consequences of government political economy produce shortage of materials and parts for manufacturing. These two situations produce delays on design, manufacturing and installation of the ER devices.

IV. CONCLUSIONS AND RECOMMENDATIONS

The Methodology proposed in this work is a "chain" of methods which are tested and very useful. The innovation is the combination and order on different stages of the methodology proposed which permits the following optimizations.

1. Optimization of the RE sources and places for RE converters location in micro scale map considerations.
2. Optimization of the Human Resources reducing risks and detecting critical tasks by means of Holistic analysis.
3. Detailed study of user demand (UNCo in this case),which permits to make a plan of Rational Use of Energy and to reduce energy consumption and costs.
4. Optimizing the conceptual design using adequate technology for the Renewable Energy Converters taking into account the available materials in the place of application, in our case Argentina.
5. Taking into account the Life Cycle Analysis, it permits to optimize the following activities:
    - Optimization energy consumption during design, manufacturing, installation operation, disasembling and recycling.
    - Optimization of materials available in Argentina, during construcion reducing leftovers and discards. Recycling considerations trying to re-use materials or parts in new applications such as blades used in ornamental ones in public squares.
    - Training for users (if they asks during purchasing) to be included in tasks of installation, operation and maintenance, optimizing human resources and reducing costs.
6. Total CO_2 avoided emissions by means of Energy Balance Analysis [13] and Clean development Mechanism [16], which permit to ask green bonus emission in the future. The emitted CO_2 in the case of CEECRC, can be understood as it should generate 4.4 months to offset emissions throughout the life cycle. This value is calculated by dividing the generation of energy used in the life cycle over annual generation for CEECRC at full power.

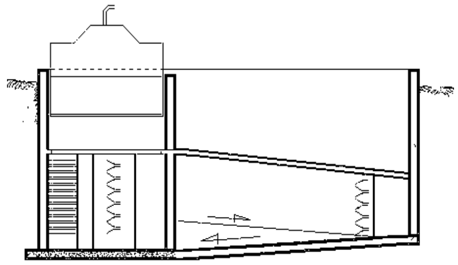

Fig 5: Third Generation of Anaerobic Digester [20].

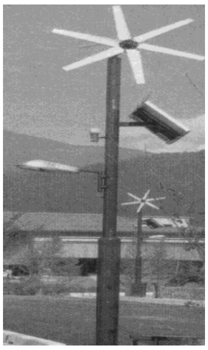

Fig 6: PV Light System Combined With Small Wind Turbine [11].

Other advantage is that the different ER converters can be replicated and manufactured for other users with their same needs in other places of Argentina or other country in the world with similar conditions. Some of then can be made as free hardware and other with franchasing asked to the former manufacturer.

ACKNOWLEDGMENT

Particularly for all the colleages and students that believe that this project can be possible in a country that continuously is changing border conditions in social, economical, environmental and technological aspects.

REFERENCES

[1] C. Labriola, E. Sierra,"Renewable Energy a topic for motivation in Formal Education", Annual Meeting of Argentinean Renewable Energy Association, (ASADES 2006), paper E-25, Buenos Aires, November 2006.

[2] C. Labriola, R. Pérez, Research Project FAIN 4/160: "Central Eléctrica Escuela a partir de Recursos Renovables Combinados". G.E.S, EFUNCo. Director: Labriola, C. Co-Director: Pérez, R.. Period 1/2010 a 12/2013.

[3] C. Palese, C. Labriola, J. Lassig, "Modeling at Micro scale of wind parameters for a turbine test workshop in Neuquén" Latin-American Congress of Wind Engineering, (CLIV 2012) paper M-58, La Plata, Buenos Aires, December 5-7, 2012.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 2, Issue 9, March 2013

[4] N. Baeza, Graduate Thesis: "Anaerobic digester for EFUNCo using domestic organic matter to obtain biogas for electrical generation", unpublished, Director: C. Labriola, 2012-2013.

[5] D. Quiroga, L. Montenegro, Graduate Thesis: "Biodiesel produced by fat from stress of microalgae of waste effluent", unpublished, Director: C. Labriola, Co-Director: E. Rosembaun, 2012-2013.

[6] A. Koestler, "The Ghost in the Machine" Edited by Arkana, 1967.

[7] I. Ferraris, C. Labriola, "Análisis de Riesgo aplicado a Proyectos de Enseñanza de la Ingeniería" Argentinean Congress of Mechanical Engineering (CAIM 2010), paper E-52, San Juan, November 2010.

[8] L. González, M. Moya, Graduate Thesis: "Estudio de Optimización Técnico-Económica en el uso de la Energía Eléctrica en la FIUNCo", Director: C. Roldán, EFUNCo, 2008-2009.

[9] C. Labriola; Postgraduate Thesis: "Study of Darrieus -Troposkien rotor for gust of wind regime in Patagonia, Argentina", Master Course, Qualification: A with Merit, University of Reading, Berkshire, United Kingdom, 12/2000

[10] A. Marchegiani, "Turgo Development and Installation for Micro-Hydro training", project required by Energy Utility Service Company of Neuquén (EPEN), Department of Mechanics, EFUNCo, 2010.

[11] LVM-ltd.com, "PV-Wind light system", Bedforshire, UK, 2010.

[12] VESTAS, "Life Cycle Assessment", for turbines of 3MW, Denmark, 23-03-2005.

[13] C. Aguilera, Graduate Thesis: "Estudio del CO_2 evitado por MW instalado con el uso de Energía Eólica, a través del análisis y adaptación del Ciclo de Vida y Balance de Energía", Qualification 10, Director: MSc. C. Labriola, Faculty on Helth and Environmental Sciences, UNCo, December 2008.

[14] P.C.C. of UN-AMS, "Approved Small Scale Methodologies, Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories". United Nations, Version 14, 2010.

[15] C. Labriola, A. Palavecino, I. Ferraris, "Life Cycle of a School Power Station with Combined Renewable Fuels - Avoided CO_2 Emissions Estimated with CDM", Iberoamerican Congress of Life Cycle Analysis, CILCA, Mendoza, Argentina.

[16] Palavecino, A., Postgraduate Thesis: "Estudio del CO_2 evitado por la Central Eléctrica Escuela de la FIUNCo", EFUNCo. Qualification: 10 with Merit. Director: MSc. C. Labriola. 2009-2012

[17] C. Labriola, et. al. "Installation of School Power Station", Argentinean Congress of Mechanical Engineering (CAIM 2012), paper A-38, San Juan, October, 2-5, 2012.

[18] Indal Industries, "Report of Darrieus-Troposkien vertical Axis Wind Turbine", 1995.

[19] ITDG, Intermediate Technologies Development Group "Manual of Micro-Hydro turbines", London, 1999.

[20] http://digestión anaerobica/planos/ digestor tercera generacion.

[21] C. Labriola, et. al., "Academia Units of UNCo using electricity by means of Renewable Energy Sources" World Engineering Education Forum (WEEF 2012), paper E-67, October, 21-24, 2012.

AUTHOR'S PROFILE

Carlos V. M. Labriola: He is Researcher and Associated Professor in Electrical Department of Faculty of Engineering in National University of Comahue. His studies are: Electromechanical Engineer from University of Buenos Aires (1985), Master of Science in Renewable Energy and The Environment from The University of Reading, Departemnt of Engineering, United Kingdom, (2000), Specialist on Management and Engineering of Maintenance, Austral University, Buenos Aires (2005). He is continuing PHD studies on Engineering in UNCo actually. He is the head of Energy and Sustainability Group and Renewable Energy Source Centre of EFUNCo. He wrote 49 papers related on RE in the foollowing areas: source analysis, technology developments, social applications and in education. This work permits him to be consultant in RE technology and education. He is researcher in RE since 1996 and represents Argentina during the World Renewable Energy Congress, 2006 on RTD-Economic European Community meeting.

Isabel Cecilia Ferraris. She is Researcher and Professor of Physics in Physics Department of EFUNCo. Her studies are: Civil Engineer from National University of Buenos Aires (1983), postgraduate studies on Risk Analysis, University of Bristol, United Kingdom (2000). She is researcher since 1996 and wrote 22 papers related on Education and Risk Analysis.

Jorge Lassig: He is Researcher and Head Professor in Mechanics of fluids, of Department of Mechanics, Faculty of Engineering in National University of Comahue. His studies are: Aeronautical Engineer from University of La Plata and PHD on Meteorological Sciences from University of Mar del Plata. He is the head of Wind Engineering Group and this group is part of the Renewable Energy Source Centre of EFUNCo. He wrote more than 60 papers related on RE in wind resource analysis, wind technology developments and social applications.

Claudia Palese. She is Researcher and Professor of Mechanics of Fluids in Mechanical Department of EFUNCo. Her studies are: graduate in Meteorological Sciences from National University of La Plata and Master in Meteorological Sciences in National University of Mar del Plata. She is researcher since 1995 and wrote 20 papers related on RE sources particularly Wind Energy.