ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN

United Nations Development Account project
Promoting Energy Efficiency Investments
for Climate Change Mitigation and Sustainable Development

Case study

URUGUAY

IMPROVING ENERGY EFFICIENCY IN THE URUGUAY RICE INDUSTRY FOR CLIMATE CHANGE MITIGATION AND SUSTAINABLE DEVELOPMENT

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Summary

Energy efficiency is one of the most important tools to address the increasing energy demand. The experience from the international scene shows that energy efficiency projects help to improve energy security, increases competitiveness, creates jobs, reduces the vulnerability to high and volatile prices and also contributes to environmental care.

In Uruguay, energy is a particularly relevant aspect, in fact there is a National Energy Policy agreed by all the political parties with parliamentary representation since 2010. In this policy the need to develop measures to reduce energy costs trough energy efficiency and use of non conventional renewable energy in the energy matrix, among others aspects are emphasized.

Part I of this paper address this issue in general and make particularly emphasis in the rice industrialization sector, proposing different ways for energy conservation and energy efficiency.

The energy matrix is described from the generation point of view and the relevant customer tariff issues where actions will be taken are considered.

Then, the proposed energy efficiency actions are described also the policy and technical framework for investments in the country is discussed.

The aim of the case study is to use efficient technology with a remnant of an industrial by-product (rice husk) to cogenerate energy (electricity and heat) required for the process, minimizing the use of energy and decreasing the volume of the generated waste. According to what is described, the benefits and potential for replication of the proposed actions are highlighted. The potential identified barriers which prevents the development of this actions are mentioned at each point,

Finally, in Part II a brief discussion of the possible reforms and actions to be taken in order to solve the identified barriers are described.

Introduction

The energy generation and its rational use is an issue that has become increasingly important for governments in the last few years. This is due to the fact that there are several associated issues. Either is for related reasons with the impact of energy in national economies to reducing emissions of greenhouse gases (GHG), or issues of sovereignty.

Faced with this problem, energy efficiency is one of the most important actions and has the greatest impact on reducing consumption. This paper addresses this problem by studying the actions applicable to the Uruguayan industry, as it is the rice sector industrialization. We propose the use of rice husk to co-generate electricity and heat, used by the process of industrialization of rice. The use of rice husk (by-product of the process) as energy fuel is known in Uruguay, but still to this day the rice husk, for most establishments is an environmental liability since it's not used with that or any purpose and its disposal is not solved. It has a high reproduction potential since the main characteristics of the process are the same for all establishments, only with size variation.

Through a current context analysis of the actions, from a legal, economic and sector rate standpoint the potential barriers to the development of this type of cost saving actions and energy efficiency will be identified. While there are many positive aspects and there are some experienced establishments, there are several barriers that prevent correct development of such actions in most establishments.

Finally, the potential actions to take, in order to ensure that such measures can be implemented nationwide.

PART I. Identification of EE Project type and Sector with scale up potential at the national level

(a) The energy problem in Uruguay: climate change mitigation and sustainable development

The increase in the concentration of most of the greenhouse gases (GHG) has modified the atmospheric composition and with it, the weather. According to the Intergovernmental Panel on Climate Change (IPCC), these emissions have doubled since 1970, being four times more intense in developed countries than in developing countries.

The international community has tried to address this problems-at least formally-since 1979, but it was not until 1992 with the Framework Convention on Climate Change that the first requirements were established to reduce GHG emissions. The Convention triggered the 1997 Kyoto Protocol, were 39 countries agreed to reduce 2% of their emissions (compared to 1990) by 2020. Then meetings in Copenhagen and Cancun took place.

According to Dr. Elizabeth Burleson1), International and Environmental Law specialist, there are four points that should act as areas of discussion in agreements: mitigation policies, adaptation policies, clean technologies transfers (using renewable energy sources) and funding to carry out different policies.

Given this global issue, the developing countries even not having the greatest impact on GHG emissions, have joined.

However, the incidence raise of developing and emerging countries in global economic growth, these countries have to face the problem of managing growing energy demands with limited energy supply based on fossil sources.

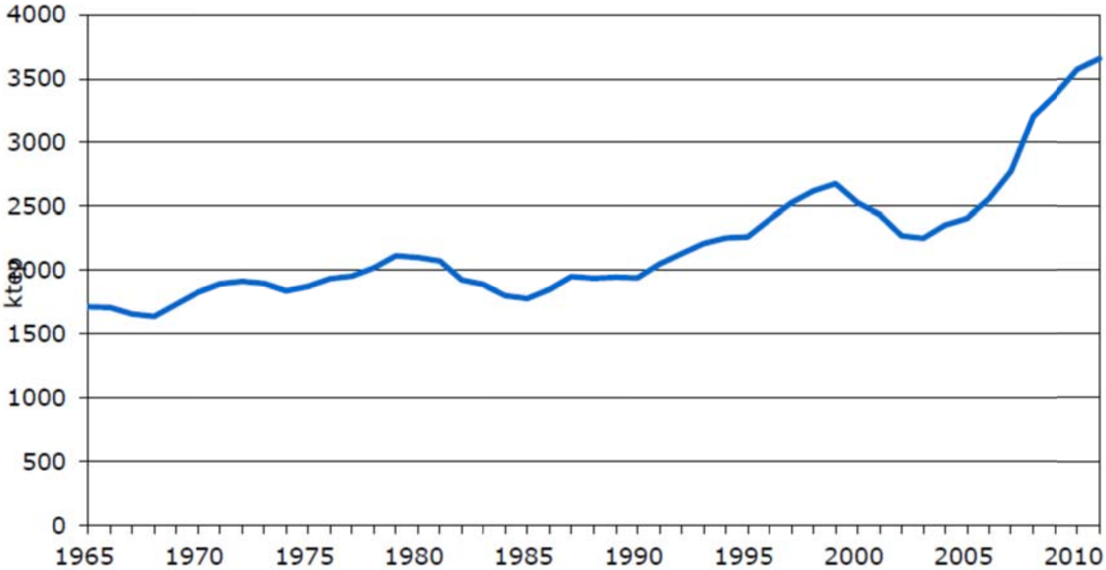
This has motivated these countries to establish energy as an issue from different perspectives.

As can be seen in the Figure 2, in Uruguay, the energy problem can be considered from five factors, with different sources and associated problems.

These factors largely explain the objectives establishment of the country's energy independence through sustainable policies since August 2008 in the Energy Policy 2005-2030 established by the Executive Branch.

In February 2010, all political parties with Parliament representation supported that energy policy. In relation to the energy supply, this Policy aims are: the diversification of the energy matrix and reduction in the oil dependence encouraging the local energy sources in general and the renewable ones in particular. When it comes to energy demand, the main focus is promoting energy efficiency. According to the latest available National Energy Balance (2011), the demand of energy in Uruguay is increasing. First the ups and downs of the countries' economic situation, with a marked growth until 1999, then, a second period of decreasing consumption until 2003, associated with a severe economic crisis, reverted in 2004 to the present. From 2004 to date, the growth demand stood at around 7 %, an historic rate for the country

FIGURE 1
PRIMARY ENERGY CONSUMPTION (NATIONAL ENERGETIC BALANCE, DNE[1], 2011)



Uruguay has been working in the Energy Efficiency Project (with GEF funds) since September 2005. There are several major advances of this project: the Energy Rating label campaigns, training and education, ESCOs promotion (Energy Service Companies), among others. However, some barriers to development were identified such as:

a) The general economic situation.

b) Weaknesses in the involved institutions (limited experience, unclear objectives, lack of interest, lack of technical capacity, etc.)

c) The difficulty of technological development by the small scale of the market, also affects access to equipment and maintenance.

d) Lack of efficiency standards.

e) Inadequate tariff structures and other shortcomings of the energy industry.

f) Limitations on the demand to implement projects (lack of information, low incidence on the global energy costs, limited funding, etc...).

g) Low number of ESCOs and their weakness.

First, as mentioned before and the first item to be highlighted in the table above, the climate change problem has overall affectation. Therefore is of national interest meeting the global targets imposed by relevant multilateral organizations.

Second, private involvement comes from high energy costs, in particular, due to the fact that own energy generation gives access to a cheaper power source than the fossil generated one, in part because it uses products that come from the same production process and in some cases, (as for the rice husk) saves the costs of waste disposal.

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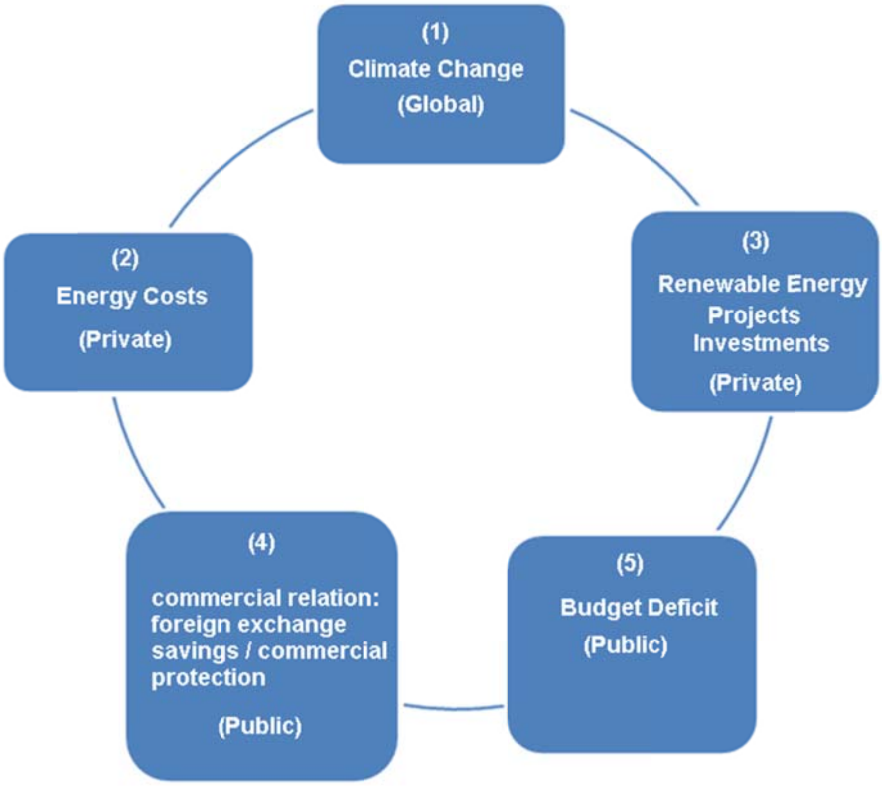
[1] DNE (Dirección Nacional de Energía): National Energy Management

Third, also from a private approach, the renewable energy industry development has an impact for the new businesses development, and facilitates investment and economic growth. In Uruguay, it is significant the impact that such projects-and others in the agro-sector boom generates in activities such as construction. A notorious example is increasing number of wind farms.

The various energy problems and incidence areas:

FIGURE 2
THE ENERGY PROBLEM



Fourth, from the public and private sector point of view, the development of renewable sources allows economic savings since Uruguay imports crude oil, and when the rainfall is insufficient it is necessary to generate energy from fossil sources. But also, from a private and public standpoint, the possibility of develop renewable sources and allow the generation of energy efficient processes allows achievements in carbon footprint, potentially resulting as a barrier to trade, in this case, limits access of Uruguayan exports to different markets, especially in developed countries.

Fifth, and with public sector importance, if electricity is generated based on fossil-source fuel due to water-deficit instances, the public sector absorbs some of the main costs of this generation in order to avoid increasing the energy costs in the private sector.

Between 2009 and 2013, this tax waiver has led to significant changes in the tax result of the public sector. According to the Ministry of Economy and Finances of Uruguay, the cost of supplying energy demand resulted in 1% of GDP2 (U$S 499 million).

In fact, facing the usual incidence of water-deficit on public finances, the authorities decided to create in 2010 the Energy Stabilization Fund (FEE; Fondo de Estabilización Energética)1) established in the National Development Corporation. The funds come from general revenues, both for the general source of revenue and contributions made by UTE.

An Energy Efficiency project as the identified one for the rice sector, given the ease of starting a process of scale up in (implemented in a traditional Uruguayan sector of agriculture

[2] Gross Domestic Product

especially using a product which an environmental liability) will be important in the private impacts, either by internalizing both energy production and reduce costs or increase security of energy supply as in the encouragement generated by the investment in the renewable energy efficiency sector. While when replicating this project for other industries another factor should be considered, this can result in a "mirror effect" for other opportunities using waste. Moreover, this project is clearly aligned with the outlined objectives in the Energy Policy of 2010, as it promotes the efficient and rational use of energy from cogeneration and the use of a renewable source (biomass) to transform environmental liabilities in energy efficiency.

(b) Uruguayan rice industry and power sectors: EE projects' characteristics

(b.1) Characteristics Uruguayan rice industry

The defining characteristics of the rice sector in Uruguay are relevant factors to enable energy efficiency projects using rice husk. The same processes at each establishment carry out the industrialization of rice in Uruguay; therefore, the results can be replicated with the same technological characteristics. Then, the scale up process is possible.

The first sector feature that facilitates this Energy Efficiency Project is the consolidation of the rice sector in the production matrix of Uruguay, this being a sector that has a great geographic diversity and economic strength.

These factors have resulted in a consolidation that determines that the rice sector has a production area of 180,000 hectares in recent years (about 1% of the national area).

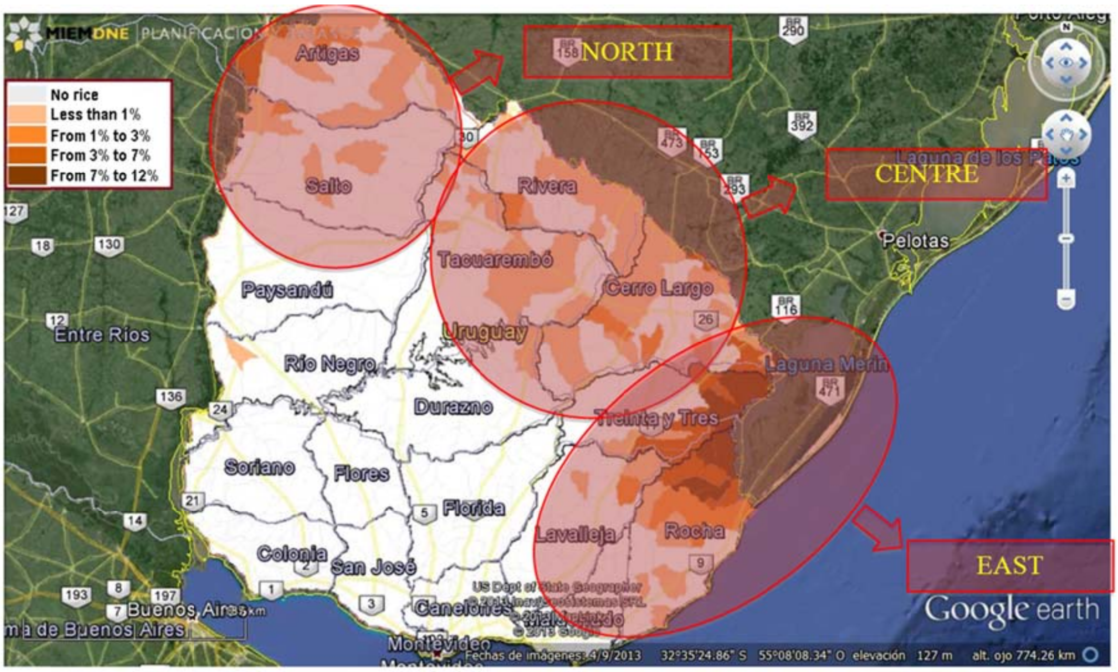
Rice activity has three influence areas:

a) East: Treinta y Tres, Cerro Largo, Lavalleja and Rocha.

b) North: Artigas, Salto, Paysandú, Rio Negro and Soriano.

c) Centre: Rivera, Tacuarembó and Durazno.

FIGURE 3
RICE PRODUCTION AREA IN URUGUAY (ENERGY MAPS, DNE)



The production distribution is shown in the following table.

TABLE 1
SURFACE STATISTICS, PRODUCTION AND RICE YIELD BASED ON SURVEY RESULTS (MGAP-DIEA)

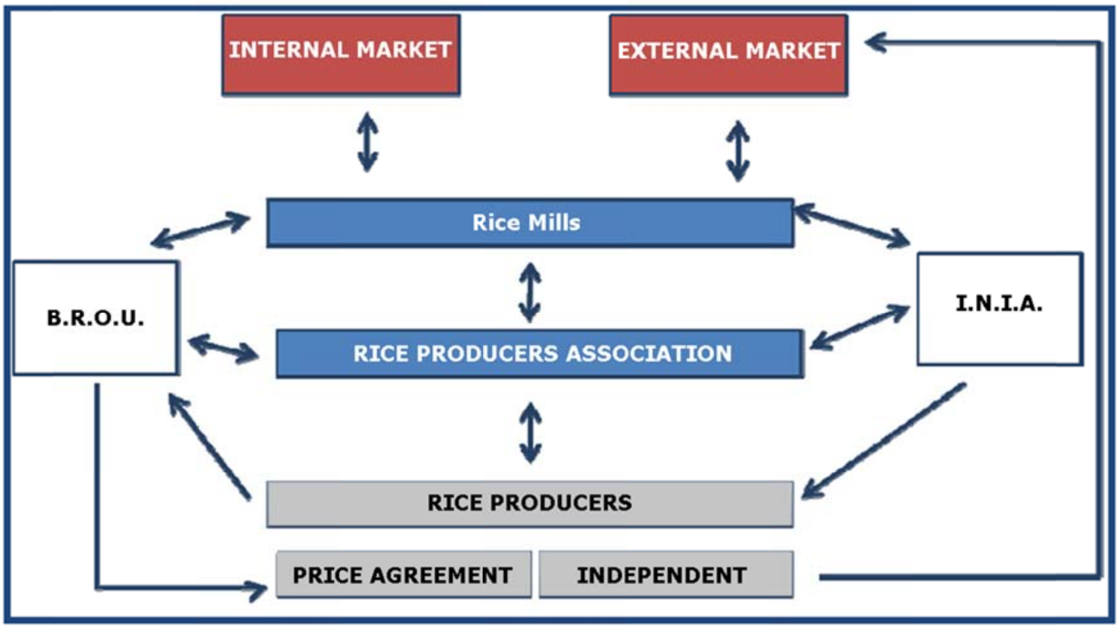
Region	04/05	05/06	06/07	07/08	08/09	09/10	10/11 [4]	11/12
NATIONAL								
Area (ha)	184,023	177,292	145,375	168,337	160,670	161,939	195,000	181,371
Production (Ton)	1.214,490	1,292,411	1,145,654	1.329,955	1,287,234	1,148,738	1.638,000	1.423,857
Yield (kg / ha seeded)	6,600	7,290	7,881	7,901	8,012	7,094	8,400	7,850
North and West [1]								
Area (ha)	40,346	38,562	28,710	36,629	29,649	34,192		35,764
Production (Ton)	279,309	304,846	237,207	304,819	241,821	251,110	no data	308,826
Yield (kg / seeded ha)	6,845	7,905	8,262	8,322	8,156	7,344		8,635
Center [2]								
Area (ha)	15,677	19,446	10,621	18,874	16,989	13,175		15,922
Production (Ton)	98,483	132,902	85,867	144,137	138,486	86,593	no data	135,006
Yield (kg / seeded ha)	6,282	6,834	8,045	7,637	8,152	6,573		8,479
East [3]								
Area (ha)	127,540	119,284	106,044	112,834	114,032	114,572		129,685
Production (Ton)	650,450	854,663	822,580	881,000	906,927	811,035	no data	980,025
Yield (kg / seeded ha)	6,706	7,165	7,757	7,808	7,953	7,079		7,557

[1] Artigas, Salto, Paysandú, Río Negro and Soriano.
[2] Rivera, Tacuarembó and Durazno.
[3] Cerro Largo, Treinta y Tres, Rocha and Lavalleja.
[4] Data provided by ACA

On the other hand, the strong vertical integration of the rice chain, led by rice mills, has allowed the introduction of technological change and improvement in the production conditions.

Finally, both public investment in infrastructure and technology, the rise of trading policies, credit and tax rebates are a sign of the rice sector importance for the State.

FIGURE 4
RICE ORGANIZATION CHART



(b.2) Role of the husk rice in the Uruguayan rice industry

As mentioned in the Table of primary production, the average production for the 2005-2012 periods is 1.3 million tons of rice per year.

Of the overall rice production it must be considered that the husk represents 20% of the produced rice, which determines a volume of 260,000 tons of rice husk per year.

At present there are only two companies that use husk to generate and sell electricity to the local distribution company (UTE[3]).

a) Galofer S.A, has a power of 14 MW, is located in Villa Sara, km 283 of Route 8, in Treinta y Tres department. The consumption of the plant is 72,000 ton/year, uses rice husk from mills that are within 130 km distance.

b) Fenirol S.A is located in Tacuarembó city; there a combination of biomass with up to 15% of rice husk is used for a 10 MW power plant.

FIGURE 5
LOCATION OF ENERGY GENERATION WITH RICE HUSK PROJECTS.

These two projects (Galofer S.A. and Tacuarembó-Fenirol S.A.) consume approximately 105,000 tons/year of rice husk, this is less than 50% of the national production.

[3] UTE (Administración Nacional de Usinas y Transmisiones Eléctricas): National Administration of Power Generation and Transmission

TABLE 2
RICE MILLS WITH THE GRATESDT PRODUCCION (OWN RICE PRODUCTION).

Rice Mill	Location	Capacity
Saman	Montevideo	500 tons per day
Saman	Varela	200 tons per day
Saman	Vergara	400 tons per day
Saman	Rio Branco	200 tons per day
Saman	Tacuarembo	200 tons per day
Saman	Tomas Gomensoro	250 tons per day
Coopar	Lascano	430 tons per day
Coopar	Rio Branco	150 tons per day
Casarone	Varela	200 tons per day
Casarone	Rio Branco	400 tons per day
Casarone	Artigas	170 tons per day
Glencore	Melo	200 tons per day
Glencore	Treinta y Tres	100 tons per day
Glencore	Placido Rosas	120 tons per day
Glencore	Tacuarembo	200 tons per day
Glencore	Colonia Palma	150 tons per day
Arrozal 33	Vergara	200 tons per day
Damboriarena	Paso La Puente	20,000 tons per year
Damboriarena	Paso Arriera	10,000 tons per year
Demelfor	Artigas	200 tons per day
Piveta	Artigas	100 tons per day
Tospil	La Charqueada	20,000 tons per year
Itaroquem	Minas de Corrales	15,000 tons per year
LDC Uruguay	Colonia Palma	100 tons per day

As was mentioned, the 50% of the husk is destinated for electricity generating plants, some with high transportation cost. A fraction of the husk can be used in cement kilns (involving husk transport).

Then, it is noteworthy that the previously described four aspects make the rice sector relevant to energy efficiency actions in Uruguay:

1) This is a full-fledged industry, with clear rules and established players with a strong integration.

2) The geographical distribution of the production is among Uruguay.

3) The use of rice husk as energy fuel is carried out in some establishments and has worldwide proven technologies.

4) The continuing public interest in the industry development, the improvements and innovations in the area.

(b.3) Uruguayan Power Sector

Regional Electric Matrix

Electricity in Latin America accounted for 23% of total energy consumption in 20071). The 57% of the electricity was obtained from the use of hydro and 40% thermal, 2.4% came from nuclear energy and other energies contributed in 1.1%.

CO2 emissions in the region had reached 4.9% of global emissions by 2007. CO2 emissions "per capita" are low compared to developed OCDE5) countries, but tend to increase due to economic growth in the region, as well as the increase in oil and gas drilling[6)].

Uruguayan Electric Matrix

As previously mentioned, the 2005-2030 Energy Policy establishes a short term goal where the participation of renewable energy sources (wind, solar, biomass waste and micro hydro) would reach 15% of the electrical energy generation.

The generation park in Uruguay in 2013 has a potency of 3,014 MW.

This includes self-generation as is the case of Fanapel[4] (8 MW), the leased machines recently installed in Punta del Tigre, with a total of 150 MW (100 MW and 50 MW turbine engines) and solar photovoltaic pilot plant Asahi in Salto (0.48 MWp).

The medium term plan includes:

- 1,100 MW of wind energy (contracts from tenders for wind power generation)
- 160 MW of Montes del Plata (central biomass cogeneration plant pulp)
- 43 MW of Bioenergy (contract from tenders for biomass generators)
- 530 MW Combined Cycle Gas Turbine (CCGT) in Punta del Tigre with natural gas
- 206 MW of solar photovoltaic (in tender)

In summary, **the projected installed park** will have the following structure:

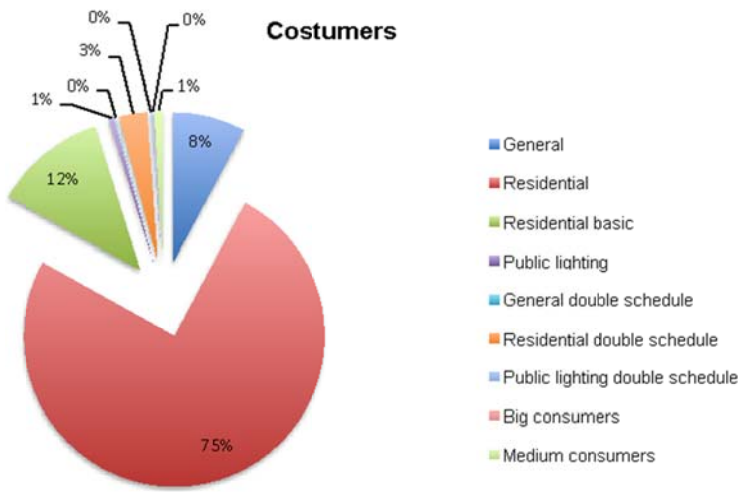
Source	Installed Power
Biomass	9 %
Wind	23 %
Fossil	35 %
Hydraulic	30 %
Solar	4%

The project will mainly be in a renewable energy context but strongly dependent on climatic factors, forcing this to have an important fossil back up. The energy saving actions and self-production helps to reduce that fossil backup participation.

Electricity tariff regime

A first approach to the economical study of the project is the consequent savings evaluation. In this case the most significant savings are associated with the power purchase diminution.

In Uruguay there are different rates depending on: the monthly consumption, the voltage, whether is public or private, whether it has or not time restrictions.



[4] a pulp mill

Annual consumption for each sector in GWh per year

	GWh
General	724
Residential	2,773
Residential basic	208
Public lighting	138
General double schedule	21
Residential	327
Public lighting double schedule	105
Big consumers	2,221
Medium consumers	1,408

The rice mills are within Big power consumers rate with a U $ S 120 / MWh fee.

(b.4) Energy Efficiency Projects' Characteristics

In Uruguay there are eight plants that generate energy from biomass, only five of them use forest biomass (wood, byproducts of the production process, debris field, etc), other one uses 85% of wood or wood waste and 15 % of rice husk, another one uses bagasse and forest biomass, and the last one uses 100% rice husk.

In the case of the plants that uses rice husks (Galofer and Fenirol), both with rice husk mills, in one case the distance is up to 130 km from the plant, therefore, the efficiency of the process is reduced since gasoil for transportation is needed, increasing (slightly) the environmental impact of the generation.

Galofer uses rice husk from the mills located within 130 km distance from the plant, and Fenirol uses rice husk from the mills near Tacuarembó city. Considering Galofer's supply radius average of 50 km, the capacity of a truck of 16 tons of rice husk and a yield of 2.5 km per liter, the power generation at the plant consumes 138,700 liters of diesel per year to transport the rice husk. Ie each MWh generated in a plant with an average supply radius of 50 km involves a consumption of 1.6 liters of diesel. For this reason and considering the geographical distribution of the rice mills that are not involved in the current energy projects, the in-situ use of rice husk is considered most suitable.

In order to have better use of rice husk, different kinds of energy efficiency projects with a nationwide high potential for scale up are identified:

a) The use of efficient technology for generating power in each mill, thus eliminating fuel transportation.

b) The use of the residual heat (cogeneration) in order to dry the rice, and thus minimizing fuel utilization for drying the rice.

c) Using the rice husk in the mill to generate electric power decreases by 90% the amount (by weight) of waste. Nowadays is burned in the open or in some cases only left in disposal areas.

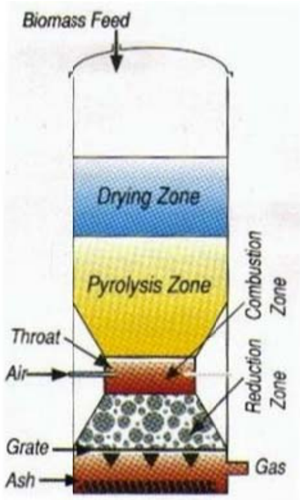
The cogeneration process starts with the rice husk from mill. The husk is collected and transported within the mill (by conveyor belts or screw conveyor) to the gasifier and then is used as fuel, this step is essential, since it avoids truck transportation.

Then, the gas produced is washed and filtered in order to be used in an internal combustion engine to generate electricity and heat that will be used for drying rice husks.

(b.4.1) Proposed technology

The proposed technology uses an internal combustion engine coupled to a generator, which can vary in a range of: 150-700 kW, that engine operates using the gas from a gasifier that uses rice husk as fuel.

FIGURE 6
PROCESSES IN A DOWNDRAFT GASIFICATION EQUIPMENT
(ANKUR SCIENTIFICS).

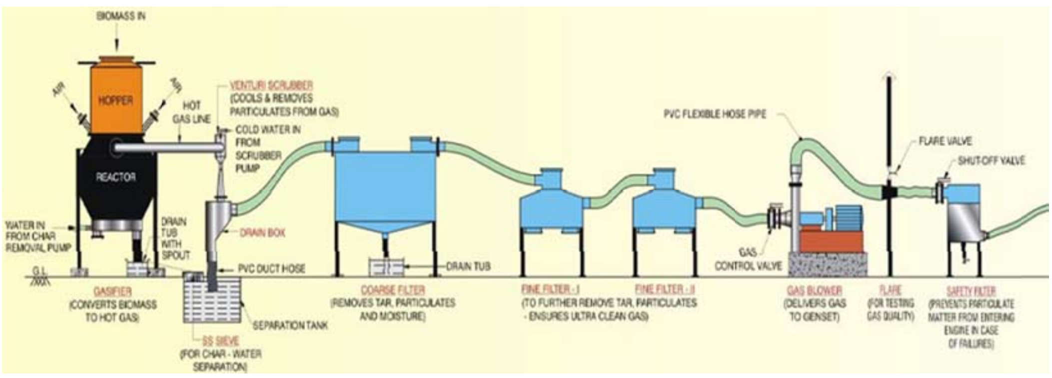


The gasifier is essentially a chemical reactor were different physicochemical processes take place. Four different processes take place in the gasifier:

- Drying of the fuel
- Pyrolysis
- Combustion
- Reduction

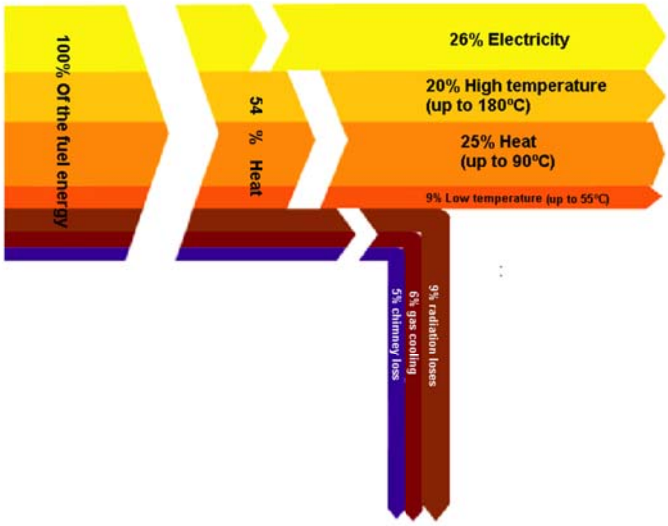
Gases from the gasifier are cleaned and filtered before being used in the internal combustion engine.

FIGURE 7
EQUIPMENT AND PROCESSES OF A SOLID BIOMASS COGENERATION PLANT
(ANKUR SCIENTIFICS).



The electrical performance of the proposed system ranges between 25-30%, but as the heat can be recovered (water at 50 ºC and water at 90 ºC), that is a 54% of the energy; we have an overall cogeneration performance of 80%.

FIGURE 8
TYPICAL EFFICIENCY COGENERATION FROM BIOMASS GASIFICATION AND INTERNAL COMBUSTION ENGINE



(c) Current Policy

(c.1) Regulatory framework of the electricity sector

The current legal framework of the electricity sector is based on Law No. 14,694 (National Electricity Law) of 1977, with its significant reform with the Law 16,832 (1997). The main change introduced by Law 16,832 is the exclusion of the generation activity as a public service, leaving open the possibility to the private sector.

This law also created the electricity market and administration agencies and relevant control organisms (ADME, UREE / URSEA), giving to the industry this new reality, then an adaptation process took place and consolidated temporally in 1999 through Decree 22/999. This was repealed in 2002, finally the following regulations were created:

General Regulation of the Regulatory Framework of the National Electricity System (Decree 276/002)

Regulation of Electricity Distribution (Decree 277/002)

Regulation of Electricity of Transmission (Decree 278/002)

Regulation of the Wholesale Electricity Market (Decree 360/002)

The electricity sector rules are relatively recent, after the electricity sector reform in 1997 and regulatory Decrees from 2002.

Unlike other countries in the region, the regulatory framework of the electricity sector does not specifically include the cogeneration. The cogeneration could be treated as a self-producer, although not always meets the requirements.

The self-producers are defined by the General Regulations of the Regulatory Framework of the National Electric System as an "Agent with an installed power generation over 500 (five hundred) kVA and whose annual generated power sold to MMEE[5] cannot exceed 50% (fifty percent) of annual generation, which consumes all or part of the energy produced.".

[5] MMEE (Mercado Mayorista de Energía Eléctrica): Wholesale Electricity Market

Current status of the Mills

The mills are currently regulated customers, meaning that their rate is fixed by the Executive Power in accordance with the distributor (UTE). If they happen to be self-producers, bilateral agreements should be established with the distributor, the latter is the one that fixes the appropriate rates. This is a significant barrier to the project because even taking into account that the Distributor is a state entity, has its own economic objectives that are not necessarily beneficial to the country.

Depending on the scale used, rice husk cogeneration can be considered self-producers (depending on if the installed capacity is greater than 500 kVA) or not. Anyway, the reference to become free customer is the most similar case, which in this case would be that of self-producer.

It is important to point out that rice mills, even with cogeneration are power and backup power dependent. Except for the drying, the other operations such as: the shelling and packaging consume electricity every day of the year, with scheduled maintenance stops. The grain drying operation is performed only in 60 days after harvest (thermal consumption).

If we consider that 50% of rice husk is available for cogeneration, a total of 63,000 MWh/year on a total of 12 to 18 establishments with an average power of 500 kW. In most cases, the establishments will have to keep buying energy to the distribution company, as the amount of rice husk produced does not cover the 100% of the power consumption of the mill.

This is of great difficulty in the development of projects of this type, because of the high risk due to the uncertainty on the rate applied to both the power and energy of complement and/or backup. The complement energy and power is the one that the distributor should provide if the self production is not enough to meet the demand, while complement is associated to the consumption when the generating equipment is stopped, either for scheduled or corrective maintenance. In the existing contracts, has been likened power consumption at special rates (UPM or industrial wind) or the existing tariff schedule (smaller biomass generators). For the mill, the certainty of an established rate would be a guarantee.

Since cogeneration is an energy efficiency action, which in this case also helps to solve an environmental liability without generating additional transport impacts, there should be considerations within the existing tariff setting backup and complement framework.

(c.1.1) Technical framework conditions for electricity exchange

Whenever a co-generator is connected to the network grid to sell its electric power, different technical conditions must been respected. Those regulations were established for this purpose. The organizations responsible for those regulations are URSEA and UTE. On the one hand URSEA, in its regulatory role, has the objective of monitoring enforcement of existing rules and establish the requirements to be met by the activities related to energy and water sectors, among others. On the other hand the distributer, UTE must maintain certain quality standards in the service, so it is necessary that the generator meet certain requirements in order to maintain the quality.

URSEA established the terms of trade in the Regulation of the Connection to the the Medium Voltage Distribution Net where certain conditions are highlighted and the technical basis to be agreed between UTE (distributor) and the generator in the connection agreement.

It is relevant to point out this aspect, as there is a technical framework of reference with clear quality parameters.

(c.2) Existing incentives

(c.2.1) Tax Incentives

From the tax incentives point of view, the regulation is framed in Law Nº 14,178 (Industrial Promotion Act) and Law Nº 16,906 (Law for the promotion and protection of investments). In Law No. 14,178, exemptions on taxes and fees in importing non-competitive teams with national industry are stated.

Another type of investment incentives are established in the Promotion and Protection of Investments of 1998 Law (Nº 16,906). There, the tax benefits are set, such as exemption from wealth tax and Value Added Tax (VAT) and Specific Internal (IMESI) related to the importation of goods, and tax returns. It also empowers the Executive to establish an accelerated depreciation regime for the purposes of the Income Tax of Industry and Trade (IRIC) and Agricultural Income Tax and Net Worth for certain goods.

In the framework of the Law, the Decree 455/007 and the modifications in the decree 443/008, specifies the application process for exemptions and classifies projects according to their magnitude, using as criteria the investment amount. It also mentions that the beneficiaries will be for those companies whose investment projects or activity is declared promoted by the Executive. The project evaluator is a Committee on the Application (COMAP), coordinated by the MEF and MIEM participation, MGAP, MTSS, OPP and Decentralization Commission. The stops and times are also exemptions established by these decrees.

In reference to Decree 455/007, the recently approved Decree 02/012 establishes methodological changes in the project evaluation and optimization of the weights of the matrix of indicators for IRAE exemption. Among other aspects, the matrix is set with measurable objectives: employment, decentralization, exports, sectoral and cleaner production or research, development and innovation, through relevant indicators defined in terms of the share of each item in the investment project. In the established criteria by the COMAP after the modification, the benefits are maintained in terms of Wealth Tax Exemptions and Rates and taxes on the importation of non-competitive with the industry items.

Finally, the decree 354/009 (also in the framework of Law Nº. 16,906) promotes, among others, the cogeneration electricity generation specifies the following scheme exemptions Income Tax of Economic Activities (IRAE):

- 90% of the net taxable income from 1 July 2009 to 31 December 2014
- 60% of the net taxable income from 1 January 2015 to 31 December 2017.
- 40% of the net taxable income from January 1 2018 to December 31, 2020

It is also mentioned that this exemption excludes those generators that do not operate in the market of forward contracts. The same decree, declares the promotion of manufacturing machinery and equipment related to the generation of electricity from renewable sources and or through cogeneration.

Furthermore, in No. 18.597 Law, of 21th September of 2009, among other things, research and development of domestic technologies in knowledge areas that contribute to the efficient use of energy and could be included in cogeneration are promoted.

From a tax perspective, the country has benefits which the project qualifies for. The lack or ineffectiveness of existing tax incentives is not considered being a fundamental barrier.

(c.2.2) Benefits for distributed generation

As was mentioned above, according to the Regulation of Transmission (approved by Decree 278/002) all users connected to the grid must pay connection and distribution fees. However, the same regulation exempts the distributed generation node whenever the network connection is demandant for power transmission. This aspect is emphasized because the cogeneration more feasible projects are in less than 5 MW.

(c.3) Regulatory barriers

Even with the enterprises operating there (Alur, Bioener/Urufor, Galofer/Arrozur, Ponlar/Danksa, Weyerhaeuser), is dependent on the distributors considerations for pricing power backup and complement to self-producers. This aspect is identified as the most significant regulatory barrier, rather than a barrier is a regulatory gap for a unique situation. The total potential would be less than 0.5 % of the installed capacity of the electrical grid, so it is not considered to give significant losses for the system or introduce relevant additional complexities. Anyway, according to the roles assigned, the distributor is not able to develop special contracts that do not conform to its basic purpose: to supply at the lowest cost. If a particular framework for cogeneration or self-generation is established, an organization should ensure the overall benefit of the country. Naturally, the electricity distribution company must align with the proposed actions.

The costs of generating one MWh for internal consumption are generally similar or even higher than buying the electricity to the distributor, the main part of the generation cost is associated with the fuel used. Thus the potential cogenerator chooses to have the usual network electricity supply (mainly steam boilers).

While there are tax incentives for cleaner production investments due to biomass and electricity high prices, they are only feasible in the cases where the biomass is a byproduct of the production process and the establishment itself needs to electricity and heat, so as to use their own biomass and thus avoid relocation costs. Thus, if this is not the case the project becomes unviable giving negative ROI rates. The costs of generating a MWh for internal consumption are generally similar or even higher than buying the distributor, with the bulk of the cost of generation associated with the consumption of fuel. This makes the potential cogenerator chooses to have the mains supply and consumption satisfaction with the usual thermal (mainly steam boilers).

(c.5) Financial access

The Energy efficiency programs in Uruguay have the same financial barriers as most of the countries in Latin America, we can mention:

- High cost of all the financing options.
- Lack of local trained professionals to assess in project risks.
- Lack of interest of local financial institutions in energy efficiency.
- Lack of understanding of banking professionals on the ways of financing efficiency programs.
- High risk Perception by local financial institutions.
- Reduced size of the energy efficiency project from the financial institutions point of view.

While the above is true, it is also true that in the study case these barriers are not an impediment to the cogeneration project financing, since there are credit lines for the rice sector, with over than 20 years of history. Because the payback periods are less than three years (if the tax return is considered), the financial leases are viable.

At present there are banks with financial leasing up to 36 months and in some cases up to 60 months for the solar photovoltaic systems installation.

(d) Energy Efficiency Potential

(d.1) Cogeneration associated benefits

(d.1.1) Primary energy saving and environmental benefits

Primary energy saving is the main significant benefit for the system. The generation at the point of electrical and thermal demand makes the overall conversion efficiency higher. The environmental benefits associated with this global energy saving will be treated later.

The following is an example for determining the overall primary energy savings by installing a cogeneration plant at any establishment. A comparison between consumption of traditional equipments and a cogeneration plant that involves thermal and electrical demand is shown. Electricity demand is considered to be supplied from power plants, this is because those are the plants that would be displaced (decreased loading or turned off) in the case that more generation capacity is incorporated or its consumption avoided.

Assuming that the establishment has a QD thermal consumption (currently ηTT) and a PD electricity (ηET), considering the install of a cogeneration plant having as a design base line the thermal demand satisfaction with thermal performance ηTCGN and ηTECGN, that generates a thermal power QG (QG = QD is imposed) and a PG electricity.

The fuel consumption of the equipments is calculated as follows:

Energy consumption from traditional equipment:

$$\mathrm{FUEL_T} = \frac{\mathrm{P_D}}{\eta_{\mathrm{ET}}} + \frac{\mathrm{Q_D}}{\eta_{\mathrm{TT}}}$$

Energy consumption from cogeneration equipment:

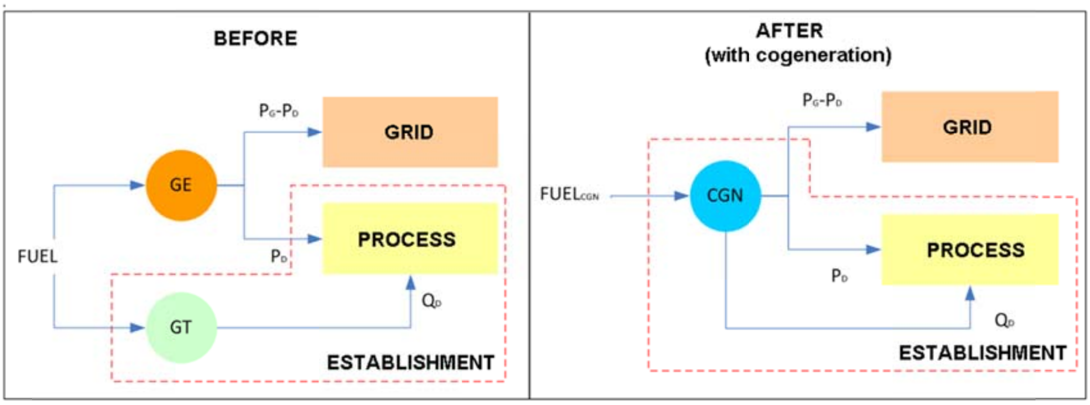
$$\mathrm{FUEL_{CGN}} = \frac{\mathrm{Q_D}}{\eta_{\mathrm{T\,CGN}}} = \frac{\mathrm{P_G}}{\eta_{\mathrm{E\,CGN}}}$$

The saving:

$$\mathrm{AHORRO\ (\%)} = \frac{\mathrm{CONSUMPTION\ BEFORE\ -\ CONSUMPTION\ AFTER}}{\mathrm{CONSUMPTION\ BEFORE}}$$

The primary energy savings must be studied in two separate cases:

The excess electricity can be sold back into the grid (QG = QD y PG > PD)

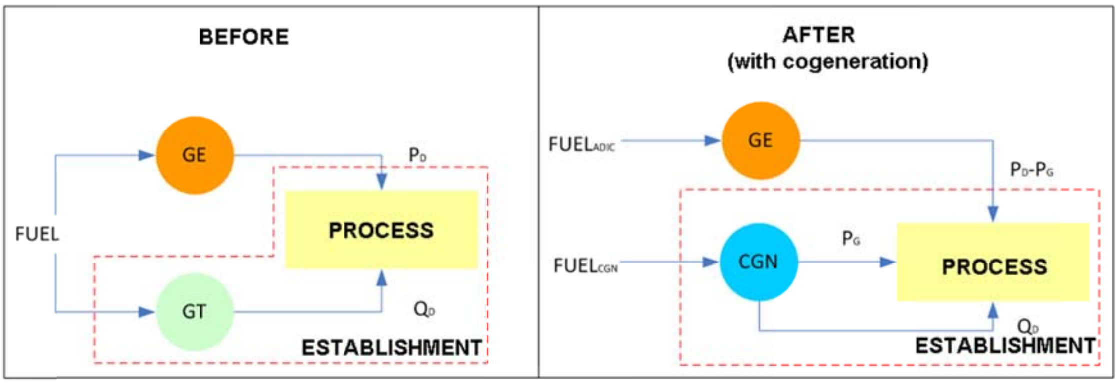


$$\mathrm{CONSUMO\ ANTES} = \mathrm{FUEL_T} + \frac{\mathrm{P_G - P_D}}{\eta_{\ \mathrm{ET}}}$$

A term that that includes the energy used to generate electricity using the traditional equipment is added.

$$\mathrm{CONSUMO\ DESPU\acute{E}S} = \mathrm{FUEL_{CGN}}$$

The plant generates electricity, but not enough to supply the whole electricity demand, so the electricity needs to be taken from the grid.(QG = QD y PG < PD)



$$\text{CONSUMO ANTES} = \text{FUEL}_\text{T}$$

$$\text{CONSUMO DESPUÉS} = \text{FUEL}_\text{CGN} + \frac{\text{P}_\text{D} - \text{P}_\text{G}}{\eta_{\text{ET}}}$$

A term that that includes the energy used to generate electricity using the traditional equipment is added to the cogeneration equipment to supply electricity demand.

For example, the average of thermal power plants in operation (Central Batlle Punta del Tigre, La Tablada, Central Maldonado) is 29%. The efficiency of a thermal purpose boiler may vary between 80% and 93% depending on: the fuel, regulation, maintenance, etc. this is called pure thermal performance. For this example considered performance will be 90% (optimistic). Therefore, assuming on one hand:

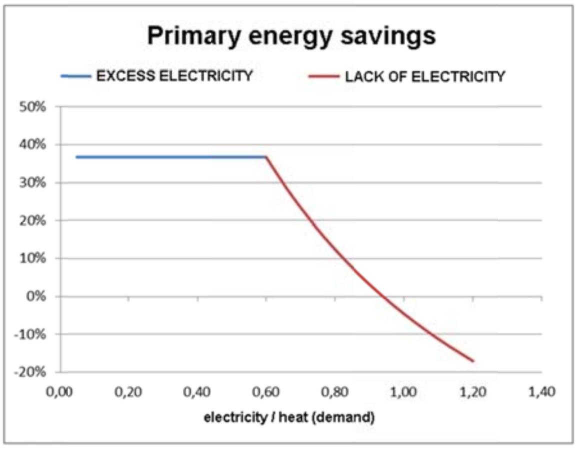
Generation Performance η_{ET}	29%
Thermal Performance η_{TT}	90%

And further, considering typical equipment cogeneration yields (whose relationship and overall performance will depend on the application and case, but may be typical plants)

Electric Performance CGN $\eta_{\text{E CGN}}$	30%
Thermal Performance CGN $\eta_{\text{T CGN}}$	50%
Global Performance CGN	80%

The savings in primary energy as a function on the PD/QD (demand) ratio is shown:

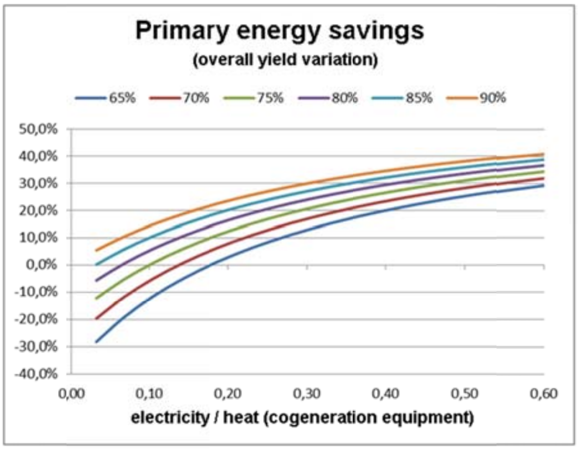
FIGURE 9
PRIMARY ENERGY SAVINGS



It can be observed as in the case of excess electricity, the primary energy saving is independent from the PD/QD ratio, only depending on the performance of traditional equipment and cogeneration. It is observed that after a certain PD/QD ratio, in the case of lack of electricity there is no saving for the system. Further analysis could be done by plant yields variations. This is because the cogeneration equipment yields varies according to: the implemented solution, technology, design, installation, etc.

With the same operations described above, and for different PG/QG rates, keeping the demand fixed. The different lines represent different overall equipment yields:

FIGURE 10
PRIMARY ENERGY SAVINGS: OVERALL EQUIPMENT YIELDS



(d.1.2) Networks relief

Given the project's scale, distributed generation could be a relief in certain sections of the network, with the consequent decrease in power losses associated with transport. This is because own consumption is prevented and it's eventually generated in other consumption points. Naturally, the project's advantage will depend on its location.

(d.1.3)Fuel Savings

The cogeneration in the mill involves the in situ use rice husk. Thus, avoiding transport cost and lowering of the cost of MWh generation.

Assuming it is possible to centralize all the remaining husk at a generation plant, like Galofer[6] with a supply distance of 50 km by road, it would take 100,000 liters of diesel per year for transportation.

(e) Assessment Methodology

To set the cogeneration system in the mills, the following aspects were considered, in particular considering a case study.

(e.1) Thermal Demand

In most plants there are rice husk dryers supplied with air heaters of 1 to 2.5 million kcal / h, those dryers are used for 60 days in the year.

During the operation mode, only one of these two heaters is used, the other one is a backup for when stop maintenance is needed.

(e.2) Electricity demand

The installed power in the Mills is between 0,7 – 1 MW, trough a UTE grid connection in a 15 kV voltage with the following prices:

Rate	Tension Level (kV)	Energy price ($/kWh)			Maximum measured power ($/kW)	Monthly Fixed Costs ($)
		Valley	Flat	Peak		
GC1	0.230 – 0.400	1.105	2.123	6.537	277.20	8133.30
GC2	6.4 – 15 – 22	1.061	2.012	5.256	182.30	8133.30
GC3	31.5	1.057	1.977	4.443	111.00	8133.30

The power consumption of the plants is assumed to be flat (with no significant variations throughout the day), i.e. the same energy is spent in each rate schedule, this results in a monomial MWh price (the mill has a flat consumption during the 24 hours of the day) of $ 2.280.

(e.3) Technology Selection

Reciprocating engine: the use of a reciprocating engine operating the gas from the gasification of rice husk is proposed. The rice husk gasifier and reciprocating engine with heat recovery system (water at 90ºC) will be used for heating the air for the rice drying.

(e.4) Assumptions used

Below the function assumptions of the plant, used for the economical pre-feasibility study of the project are shown.

Fuel to use	Rice husk
Fuel to replace	Wood
U$S / MWh UTE (GC27 rate)	120
Hours / day Generator Operation	24
Days / year Generator Operation	321
Days / year Drying	60

6 It is known that is case that cannot be given by atomization of plants, however is mentioned by way of example as a minimum.

7 GC2 : Big Power Consumers, 6 -15- 21.5 kV

(e.5) Pre-feasibility analysis

A USD 10/ton husk cost is taken (while transportation is not a requirement no additional costs will be added) and operating costs of collection systems and internal transport are considered negligible. With these assumptions, the total cost would be as follows:

Husk Cost8 (U$S / Ton)	10
Power to install (KW)	500
Kg / h Wood saving (Kg /h)	850
Wood cost (U$S / Ton)	42
Annual cost generation (Fuel and maintenance)	97,000

From these costs, and the data operation of the plant, the following savings are obtained:

Income electricity (U$S / year)	406,000
Wood saving (U$S / year)	52,000
Annual income (U$S / year)	458,000

Considering fuel costs and a USD 2.750/kWe installed investment following results are obtained:

U$S / year free	361,000
Investment (U$S)	1,375,000
Payback in months	46

Assuming an interest rate of 5%, a discount rate of 8% and an equipment life time of more than 15 years, the following results are obtained:

IRR[9] (15 years)	15 %
NPV[10] (15 years)	735,000

Note: Investment in cogeneration from rice husk qualifies as a Cleaner Production project and therefore according to the Investment Promotion Law has a 40% return on investment in IRAE11 with 5 years. In this scenario the payback investment period is 28 months with a 25% IRR (15 years).

TABLE 3
SUMMARY OF THE MAIN BENEFITS.

Main indicators of implementation			
	Installed capacity (MW)	Generated electricity12 (GWh/year)	Removed solid waste (ton/year)
Maximum Scenario	8.2	63.2	126,586
12 establishments scenario	6.3	49.1	98,162

[8] While the skin has no other use at present, a price could be assigned since it could be sold at that price.
[9] Internal Rate of Return
[10] Net Present Value
[11] IRAE (Impuesto a las Rentas de las Actividades Económicas): Income Tax on Economic Activities
[12] National interconnected system saving

PART II. Analysis of policy reforms and/or other actions required to change current conditions/barriers

(a) Social-Economic, Environmental and Policy Analysis

This point requires an assessment of the policy reforms required and/or the actions required for achieving the energy efficiency potential identified, and thus achieving the impact and benefits of energy efficiency investments.

Previously the main energy problem factors were identified and it's scope of impact. So identifies the private sector with the public sector

In this case we develop a more detailed breakdown of these characters, meaning that this group of stakeholders is related to private companies, families, the public sector.

These three actors take on different roles in order to maximize the "social cost" of the investment projects in renewable energy and energy efficiency.

In the case of private companies, they have significant challenges to internalize the production of energy in such a way to reduce energy costs and aspire to achieve a long-term energy security.

However, as mentioned, the decision to carry out an investment in renewable energy and energy efficiency, perhaps continuing the process of identifying the energy problem by operating management and then, the access to funding for a possible project to solve this energy problem.

It is in this latter case that the decision whether to take or not the decision to demand resources to finance lies in financial management.

And from this is that reside aforementioned two aspects:

a) People linked to the operational part -those involved in identifying the energy problem- have more instruments of energy management and with minimum financial management training will be able to develop the strategy needed to interact with the financial referent and facilitate the communication between the operating technical language and financial language.

(b) In the financial manager's decision, -assured the problem stated in (a), in terms that the energy problem and what this means in operational costs in the short, medium and long term for the company, is understood- with a broad knowledge of the different ways to access finance energy efficiency projects or renewable energy inclusion needed by the company.

In this case it is useful to assess the degree of financial managers' ability to evaluate the various financial instruments to which the company can access to fund energy investments (access to renewable energy and energy efficiency) according to the particular conditions of the company.

This hypothesis finds support as businesses in Uruguay have a family structure and, the companies uses bank financing, based on their own financial managers advice, as the main financial source together with the use of own resources. There is a bias due to the fact that the energy efficiency and investment in renewable energy is based in the credit quality of the firm requesting those resources, rather than the quality of the project itself. This bias benefits large companies at the expense of medium and small companies that cannot afford either to finance their own or cannot access bank credit.

The latter implies a bias towards the consideration of other alternatives by these plaintiffs of resources.

On the other side, the side of the resources suppliers, and in this case involvement of the State from a funds supplier (the Bank Republic of Uruguay finances energy efficiency and renewable energies projects) and from assuming the role of incentives articulator for the private sector to funds accessed by private companies.

In that sense, the most important role is for the State, from its energy-related institutions should bear the cost of the decision makers for the companies which is the universe of funding modalities. In this sense, training, leading some efforts at energy managers that achieves the "first installment" of decision making, including the ones in charge of the finances of the company, it should be extended to persist and deepen both the stretch between those responsible for the operational and responsible financial and between the financial institutions responsible for providing, suggest and encourage these companies access to the necessary resources to access this type of investments.

On the other hand, the Public Sector, may be called upon to play a role in articulating access to nonbank financing instruments, which allows actions regarding the identification of potential claimants of such investments, and while not being the provider of these resources (Republic Bank fulfills its role in financing, as well as the banking system in general, but with the problem of banking regulation impediments) if it can be the middleman between suppliers of funds and demanders of funds.

From another area in that defined other investments in renewable energy and energy efficiency processes, other business actors are final consumers (in this case includes organized families through access to energy in their home, as companies that are based not on a productive activity in goods but also services, such as hotels, social clubs, and government agencies). In this case the asymmetry of information, against end consumers, requires more concrete steps to access information about all the alternative investments in energy efficiency and renewable energy and how to finance them.

Both in reducing these asymmetries between private and public sector, and between the end users and the public sector, there may be other stakeholders such as managers in energy efficiency, with private characteristics, motivated by profit but aligned with the social interests.

(b) Social-Economic Analysis

(b.1) Employment generation

The project will have a significant positive impact from the employment point of view in each implemented place. Indeed, there are 6 direct jobs for each cogeneration plant to be generated for its operation; also the demand for skilled labor for the equipment maintenance should be added.

(b.2) Industrial waste recovery

Rice husk, except its uses in cement and poultry, has little marketability. The project will give commercial value to this residue, making it more sustainable for the rice industry, which is one of the most important economic activities in East zone

(b.3) Development decentralization

Beyond the aspects of job creation and energy efficiency, the development of a project as proposed in the different areas of the country with relatively lower level of development has a value in itself. The migration from the interior to the capital is at the root of the major social problems that the country is facing. This project is a small contribution to reversing that process.

(c) Environmental Analysis

The associated benefits to this project are:

- Reduction in the emissions of: CO2, CH4 y CO, among others, because of the uncontrolled combustion of rice husk. Currently, some establishments reduce their volume of waste by incineration.
- The need for suitable sites for rice husk disposal is eliminated.
- Considering all other solutions proposed for the removal of rice husk, in situ cogeneration has the significant advantage of avoiding the use of transportation. Rice husk has low density, making it very inefficient for transportation (since trucks would carry up to 16 tons).
- The generation is CO2.neutral.
- Distributed generation has clear benefits for distribution networks, because reduces current losses.

(d) Scale-up Policy Design Considerations

For the mills, the maximum power would be 13.2 MW of cogeneration installed power, distributed in equipments of less than 800 kW.

The technology is fully developed in some regions of the world where rice production is of relevance. However, it is necessary to develop local capacity for the installation, operation and maintenance of the equipments. The pilot project implementation is needed to develop associated services. Also, this shows the project's reliability to investors.

(e) Conclusions and Recommendations

1)` Although two projects with rice husk have been developed, they are large scale and involve a material transport and therefore the consumption of non-renewable energy such as diesel.

2) There is a regulatory framework that can be applied, but the regulated rate is not expected to be maintained for cogeneration, then this should be added to the current regulations in order to make the projects viable.

3) The proposed modifications to the regulatory framework are not large actions, and in this context the small cogeneration projects with rice husk would be viable.

4) While it is a globally proven technology, there is no experience in the region. Therefore, it is considered essential a pilot project implementation.

5) The pilot project implementation should assess the staff's technical capabilities, training in operation and maintenance for cogeneration equipment would be necessary.

TABLE 4
SUMMARY: IDENTIFIED BARRIERS AND ACTIONS TO SOLVE THEM

Barrier	Barrier type	Possible Actions
Uncertainty about equipment effectiveness and safety	Cultural / Technological	Development of pilot plants Dissemination of worldwide implemented technologies Dissemination of successful projects in the world
Financial access	Financial	Training of financial managers and energy managers on financial issues concerning energy, to improve the understanding for the development of projects. Training of financial institutions Credit lines establishment for this projects.
Uncertainty in backup rates	Regulatory	Clear and not punitive backup rate setting for those customers who choose to co-generate using renewable energy at small-scale (less than 1 MW)

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