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Updated information on this workshop is available at http://www.bioenergy-lamnet.org, http://bioenergia.oikos.unam.mx and http://www.anes.org.

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International Seminar on Bioenergy & Sustainable Rural Development

WORKING GROUP 2: GENERATION OF ELECTRICITY

International Seminar on Bioenergy and Sustainable Rural Development
- 5th LAMNET Project Workshop – Mexico 2003

ELECTRICITY FROM BIOFUELS IN LATIN AMERICAN SUGAR MILLS: SLOW TAKE-OFF OR LOST CHANCE?

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SUMMARY

Two real cases and eight study cases of sugar mills in Nicaragua, Honduras and Cuba are reviewed, with the purpose of identifying practical limiting factors to expanded co-generation and round-the year generation of electricity based on biomass fuels. Biomass availability, technology and equipment for steam and power generation, manpower, transportation, capital requirements, and access to the market are analyzed.

It is concluded that limiting factors are not physical or technical, but financial and institutional. Access to fresh capital and difficulties to arrive at adequate Power Purchase Agreements are the main barriers to overcome in order to realize the sugar mills potential for supplying power and energy to the national grids. Some alternatives to overcome these barriers are suggested.

Key words: sugar industry, co-generation, biomass, Power Purchase Agreement.

1. INTRODUCTION

Biomass-based electricity generation is not a new issue for sugar industry. Given its ample availability of biomass residues and high demand of mechanical and thermal energy, cogeneration of heat and power is a basic need for every sugar mill.

In Latin-America, most sugar mills built in the sixties and seventies were designed –and operated- to fulfill their needs of steam and power during the milling season, using bagasse as their main source of energy. “Unbalanced mills” needed some additional fuels – usually fuel oil or fuelwood -, and “well balanced mills” used up all the bagasse they produced, with small surpluses left over for start-up in the next season. Regularly, no attempt was made to achieve high efficiency levels in bagasse burning or electricity co-generation, since a profitable market did not exist, neither for surplus bagasse nor for electricity sales.

This situation begun to change during the late seventies, as oil prices soared and the hard currency costs of oil imports became an increasingly heavier burden for many Latin-American countries. By the early eighties the possibility to generate electricity using biomass at sugar mills was the object of many feasibility studies and even full-fledged projects, all around the Region.

Since the very beginning, two main, diverging approaches were followed:

- low-investment, medium efficiency, proven technologies based on Rankine cycle and burning available fuels such as bagasse, cane residues and fuelwood were proposed to foster electricity generation, extending it to cover most or all of the off-season, and
- high-investment, high efficiency, new technologies such as improved burning in fluidized-bed boilers, or biomass gasification coupled to combined-cycle schemes (gas and steam turbines) were suggested as a way to maximize power generation for the national power grids.

Most sugar mills owners tended to favor the first approach, since it fitted with little financial and technical effort into their standard practices and equipment. But most energy planners and researchers felt it better to try the higher efficiency options, which in the long term should be more sustainable (and also, allegedly, more profitable).

In the meantime, a rather hot debate took place, regarding electricity prices. State-owned power companies stated that the marginal cost of new hydro plants should be the upper limit for additional power to be supplied into the national grids by sugar mills. But sugar industry pretended at least the actual cost of fuel oil or diesel oil fueled utilities. An agreement was never reached, even if in many cases the national power companies could not meet the increasing demand for electricity and had to enter into costly Power Purchase Agreements (PPAs) with privately owned, diesel or natural gas fired plants which were hastily set up when power shortages and delayed hydro projects forced them to look for independent power suppliers. This was the case in the late nineties all over Central America, and also became the fashion in Brazil in the first years of the new century.

The main subject of this paper is to review and analyze the reasons for this lost opportunity: to identify the main factors that in practice have hindered the use of biofuels as a real alternative for electricity generation by the Latin-American sugar industry.

2. REAL CASES

Perhaps the earliest Latin-American proposals for expanded electricity generation in sugar mills appeared in Nicaragua, around 1981. Several alternatives were briefly analyzed by the Instituto Nacional de Energía (INE), making clear that co-generation during milling season could be competitive if medium pressure (42 Bar), high efficiency boilers were available and extraction-condensing turbines installed. But since no mill had this type of boiler, nor plans for boilers replacement, the idea was put aside "for the meantime".

In 1982 feasibility studies were commenced for a new mill. Based on a standard Cuban design, with 7,000 ton/day crushing capacity, the new plant was to have 4 boilers producing 180 t/hr of steam at 42 Bar. The power house would take 3 back- pressure turbines, 4 MW each, enough to attend the mill power demand, but not to supply the electricity needed by irrigation system.

Because 15 to 20% bagasse surplus could be achieved with these new boilers, alternative schemes were analyzed to make full use of this excess fuel and maximize installed power. The chosen solution incorporated a fifth boiler and a 12 MW extraction-condensing turbine, needed to burn all available bagasse and make use of surplus steam during the milling season.

Moreover, it included a 9 MW low pressure condensing turbine to close the steam cycle, making it possible to operate the power plant at 24 MW in the off-season. To provide fuel for this 5-month period, forest plantations were planned on the non irrigated "corners" left by the central-pivot irrigation systems and other non-irrigated lands. Highly optimistic yield forecasts suggested that 5,000 ha would be enough to produce some 225,000 t/yr of air dried wood, allowing to operate the power plant for 330 days/yr.

Since installed power capacity for the whole national system was around 300 MW at the time, this sole project would increase it by 12%, and could generate around 24% of all Nicaraguan electricity.

The new, state-owned sugar mill "Victoria de Julio" was constructed and began operations in 1985. Forest plantation started in 1983, reaching some 3,000 ha by year 2000. But a Power Purchase Agreement (PPA) was never signed by INE, the state-owned power company. The sugar mill asked for a price equivalent to the cost of substituted oil (around 67 US$/MWh) while INE offered the estimated marginal cost of future hydro-power plants still on their drawing boards, i.e. 32 US$/MWh. Negotiations dragged along the years, temporary agreements were made and broken, until the mill bankrupted and closed operations in 2002, with the condensing turbines still in their crates.

In the meantime, a privately-owned sugar company (Nicaragua Sugar Estates) took interest in the concept, installed a new boiler and power plant, and started in 1990 an afforestation plan. During 1999 –in the middle of an energy supply crisis- the firm signed an agreement to generate up to 19 MW for the national power grid in the off-season, burning fuel oil provided by INE. In 2002, it begun to replace fuel oil by wood chips obtained from 6,000 ha of its eucalyptus plantations. The concept worked for the "Nicaragua Sugar Estates", even if it did not for the "Victoria de Julio"; in the same country, at the same time, with the same technology.

3. STUDY CASES

Between 1998 and 2001 FAO Technical Cooperation Program executed two projects focused on dendroenergy issues in Honduras and Cuba: TCP/HON/6713 and TCP/CUB/8925. One of their objectives was to assess the actual and potential role of forests and other biomass resources for energy production.

Comprehensive studies performed by national technical teams with the assistance of international experts found that fuelwood and charcoal were the most important source of energy for the residential sector in both countries. It was also noted that forest resources were used below its potential, leaving ample opportunities to substitute for other commercial energy carriers.

Several study cases were conducted at profile level within the sugar industry, aiming to assess the potential for enhanced cogeneration in the milling season and extended generation in the off-season, using Bagasse (BG), Cane Harvest Residues (CHR) –leaves and tops- and fuelwood (FW) as fuels. Results are summarized in Table 1.

Table 1 excludes one case with a more complex array involving four sugar mills, one sugar refinery and one alcohol distillery coupled to a power plant, which is currently under study in Cuba. In this case, a new power plant (about 45 MW) would use surplus BG and CHR from the mills and feed low pressure steam to the distillery. In the off-season, BG and CHR would be supplemented by FW.

Table 1. Cogeneration and Expanded Generation Profiles in Sugar Mills

Site COUNTRY	Net Generation		Investment Total	Investment Specific	Direct Operational Costs (1)	Pay-back time
	M W	MWh/yr	US$	$/MW	$/MWh	*Years*
AYSA	**4.7**	**18,945**	**52,000**	**11**	**12 ~ 40**	**0.8**
Tres Valles	**6.5**	**26,035**	**1,380,000**	**212**	**12 ~ 42**	**1.8**
AZUNOSA	**24.0**	**46,871**	**4,820,000**	**201**	**8 ~ 21**	**5.9**
La Grecia	**1.0**	**3,600**	**240,000**	**240**	**n. d.**	**1.2**
HONDURAS	**36.2**	**95,451**	**6,492,000**	**179**		
FNTA 1	**5.0**	**35,330**	**2,660,000**	**532**	**29**	**2.6**
FNTA 2	**15.0**	**55,296**	**3,220,000**	**214**	**26**	**1.5**
30 Noviembre	**11.0**	**86,400**	**6,500,000**	**591**	**28**	**2.7**
A. Martinez	**7.0**	**53,700**	**4,020,000**	**574**	**28**	**2.1**
CUBA	**38.0**	**230,726**	**16,400,000**	**477**		

(1) includes fuel procurement / transportation / preparation, plus op. & main. of power plant .
Sources: FAO, 1998 and FAO, 2000, modified.

Even if data from the study cases above can be considered only as approximated and may have 20% margin of error on costs and investments estimates, pay-back time is mostly below 3 years, a very attractive figure in present times.

4. LIMITING FACTORS

One of the first conditions required by the national power companies everywhere is that prospective independent producers give some guaranties of their capability to keep a regular, more or less constant delivery of power to the national grid. Thus, **availability of biomass fuels,** sufficient to sustain around-the-year generation was one of the main concerns in both countries. In all study cases it was found that *bagasse and cane harvest residues* were just enough to extend generation for two months per year, so *fuelwood* as a supplementary fuel would have to be used. Table 1 presents only those cases where enough FW resources could be found for sustainable production within economic radius of transport, namely 120 km. Readily accessible sawmill residues and land-clearing debris were considered a first supply option, taking advantage of their very low procurement cost. Native forests were found to be quite productive, low-cost and sustainable sources, if properly managed. Due to its higher cost and delayed availability, plantation fuelwood was accounted for as a last option.

A first technological limiting factor was the **type and condition of existing boilers**. The mills with low pressure steam generators (below 28 Bar), as well as those with old boilers which replacement was not planned in the short term were excluded from the analysis, because of its low efficiency and poor performance. Since the lack of condensing or extraction-condensing turbines was the rule, the addition of this type of machines was the main investment requirement, jointly with additional transformers and wood processing equipment. To keep investment costs within acceptable levels, available second-hand turbo-generators were selected in most cases, often sacrificing some points in the efficiency equation in favor of ready access and low cost.

Manpower, both in quantitative and qualitative terms was generally judged as adequate to run extended generation schemes. Boilerhouse maintenance schedules, which regularly take several months per year in the sugar industry, could be accommodated in roughly one month. It was also found that **transportation equipment** was always enough to haul supplementary fuels (CHR and FW) during the off-season, when it usually stands idle or queuing for repairs.

Investment capital was felt as the main limiting factor by most mill owners and managers, in spite of the comparatively reduced amounts envisaged. This is not surprising when the poor financial performance of the sugar industry as a whole is taken into consideration. After twenty years of very low international prices and stagnated demand for raw sugar, most sugar companies are heavily indebted and fighting hardly to survive.

The main obstacles to undertake the production of electricity for the national grid were always the **uncertainty about electricity prices** and the **difficulties to negotiate PPAs** in favorable terms, or at least in such terms as required to ease the way for sugar mills to enter into the electrical market. Lengthy discussions and several seminaries were held with representatives of the electricity sector, with little –if any- practical results. Engineers and economists in the national power companies planning departments agreed, in principle, with the technical feasibility of some proposals, but decision-making bodies rejected the idea of out-of-the-business companies operating as reliable and profitable electricity producers. They preferred dedicated power plants, owned and operated by their colleagues, burning commercial, standard fuels.

5. OVERCOMING THE BARRIERS

According to the cases analyzed in our work, the limiting factors for co-generation and extended generation of electricity in the sugar industry are not of a physical or technical nature: biomass resources, technology and equipment for steam and power generation, fuel transportation and other ancillary equipment, as well as qualified manpower are already existent in (or easily accessible to) most sugar mills. It appears that the main barriers are financial and institutional.

Financial Barriers

On one side, the scarcity of investment funds originated in their own cash-flows and the burden of their debts mean that most mills cannot cope with the financial requirements that are needed to undertake this new line of business, even if it offers very short pay-back periods. Sugar industry was not a favorite client for commercial banks in the last years, and had to look for financing from state banks, in more or less concessional terms, just to stay alive. State subsidies for sugar production, either in direct form or in the way of high import taxes, have been another survival aid to the industry in most Latin American countries. Understandably, access to fresh commercial financing for new ventures is not easy for sugar companies: this is a first barrier to overcome.
A second barrier to be lifted, probably the heaviest, is the fact that power companies seem quite reluctant to enter into PPAs with sugar industry. If medium term contracts at reasonable prices were signed in advance, the mills could walk into a bank and ask for credit, offering the signed PPA as a collateral, so overcoming the financial barrier. But the power company wants to see proofs first: proofs of mills capability and reliability to supply energy to the grid and fit into the interconnected system -and not "just for a while"-.

This fact acts as a negative feed-back in the process of decision taking by sugar companies, placing them in front of an iron dilemma: either they accept the low prices currently offered, take the investment risk and start operations in order to demonstrate capability and reliability as independent power producers, in the hope to negotiate a better PPA some years ahead, or leave it aside and miss the chance.

Another opportunity could exist if new partners would be interested to get into the business, venturing fresh capital and taking some of the risks. This could be an interesting option for diversified holdings with interests in energy intensive industries such as cement or mining, provided a free market exists for electricity, private supply contracts between independent producers and consumers are allowed, and transportation tariffs are reasonable. By investing in amplified generation schemes in sugar mills, the new investors could celebrate supply contracts with the mills, buying power and energy blocks tailored to their needs at a mutually profitable price. Thus, the price barrier and the PPA barrier would simultaneously be by-passed, at least partially.

Institutional Barriers

Reluctance to integrate independent power producers (IPPs) in Latin-american grids is a serious barrier. It is an inheritance of past decades, where state-owned companies were viewed as a “natural monopoly”, and also a prime national asset. Managers and technicians formed in these traditions might accept that, in the present state of affaires, the existence of such producers is a necessary evil, but do not tend to consider them as a permanent component of the national system. This is a fact, well reflected by most Development Master Plans issued in the last two decades, where small and medium thermal units keep seeping into the systems while big hydro projects are deferred, and biomass recedes towards a distant horizon.

Modernization of the electricity market, coupled to de-regulation and new legal frames have opened ways that in several countries allow IPPs to enter into the market, with the exception of Cuba, a country that keeps centralized ownership and operation of power plants, transportation and distribution grids. But an open, fluid, competitive market for small blocks of power and energy is not yet a reality in most countries. This constitutes another important barrier for small, prospective IPPs like sugar mills.

6. CONCLUSIONS

Biomass-based electricity co-generation and generation is slowly taking-off in Latin-American sugar mills. A few successful cases appear here and there, mostly in the manner of marginal undertakings in those mills with integrated sugar refineries.
But in spite of the dire need to replace oil imports and to expand power supply in Latin America, many readily available opportunities are and have been lost.

Commercially established technology using available low-cost biomass fuels, coupled to marginal investments to allow for extended generation in the off-season seem to be an appropriate solution, if the goal is interconnection of sugar mills to the national grid. Efficiency levels are low, but this is not so important when fuel is cheap. Taking into consideration that maturing time for this type of projects is usually below two years, erection and start-up take less than one year, and pay-back time is usually below three years, it can be concluded that this approach offers fast response and great flexibility.

The main barriers to overcome are financial (scarcity of investment funds within the sugar industry, difficulties to get loans from commercial banks, little interest from the part of new private investors) and institutional (reluctance of public companies to buy power from independent producers, complicated or unclear rules to access the electricity market). Many opportunities were lost in the last two decades, and will also be lost in the future if these barriers are not lifted.

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