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# AN OVERVIEW OF SUGAR CANE COGENERATION IN SIX CENTRAL AMERICAN COUNTRIES

**BUN-CA**
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## EXECUTIVE SUMMARY

This study aims to discuss and present sugar production in six Central American countries from the perspective of the sector's potential contribution to electricity generation, and, to a lesser extent, discuss the issues of market sustainability for the region's sugar production.

The sugar industry has long been a pivotal sector of the Central American economies. In most countries of the region, sugarcane accounts for about one-third of agriculturally generated revenues. Some 350,000 hectares of land are currently planted with sugarcane, making this sector a leading user of agricultural land in the region, as well as a major employer, providing an estimated 200,000 direct jobs regionwide.

Guatemala is the region's leading sugar producer with 52% of total output, followed by Costa Rica and El Salvador with 12.5% each, Nicaragua 10.7%, Honduras 8%, and Panama with 4.6%. There is a general perception in Central America that if the trend to eliminate subsidies continues over the next few years, the price would adjust to levels that are superior to recent international market prices.

Central America's sugarcane industry consists of 61 factories with a total crushing capacity of around 200,000 tons of cane per day. The average size of the factories is 3,000-3,500 TCD (Tons of Cane per Day), though capacity varies tremendously from around 600 TCD in smaller mills, to more than 15,000 TCD in the largest facilities. Together, these plants process over 26 million tons of cane per year, producing about 2.6 million metric tons of sugar and over one million tons of molasses (the average crushing season being 160 days).

Productivity rates vary greatly from one country to another. Guatemala has the highest rate, producing about 81 tons of cane/hectare, and Panama has the lowest with about 60 tons of cane/hectare. Most of the other countries average around 66-70 tons of cane/hectare, and normally produce from 94-104 kg sugar per ton of cane processed.

Although information is somewhat erratic in the area of bagasse production, it is estimated that 30-32% of processed cane becomes bagasse at around 50% moisture content, producing a total of around 8.4 million tons of bagasse, which is mainly used as boiler feedstock for power and process heat generation in sugar mills.

Since bagasse has been a virtually cost free fuel (or is at least perceived as such), local mills have traditionally had no incentive to use the energy from bagasse more efficiently. Consequently, most mills use low pressure boilers and low efficiency single cycle turbogenerators, which require three to four times the amount of bagasse to produce a kWh, compared with more efficient sugar factories in other latitudes.

Depending on the size of the mill, the age of the refining technology and competitiveness of the mill owners, the different country reports prepared by BUN-Central America in 1997

show values ranging from 460-580 kg steam/ton of cane processed and values from 10-40 kg steam/kWh generated.

Based on individual responses to the factors affecting the development of the sugarcane processing industry, different sugar mills have begun looking at the potential of cogeneration for export power and as a new key business for the sugar industry. In almost every country in the region there are examples of mills implementing or evaluating very diverse projects for interconnection with transmission lines in order to exchange surplus power and energy during off-season periods. Some of those projects imply a substantial investment in revamping the mills, while others may involve small surpluses produced from very simple generation cycles (non condensing, low pressures, etc.).

In terms of the overall energy context, one out of every two Central Americans, on average, does not have access to electricity services from the public grid. There is also great disparity in terms of per capita consumption, ranging from as low as 274 kWh per capita in Nicaragua to about 1,300 kWh per capita in Costa Rica. Power and energy production capacities in the region will need to almost double within the next 6-7 years, requiring the addition of over 3,000 MW of installed power. Current installed power and electricity demands in Central America are of the order of 4,500 MW and 20,000 GWh, respectively.

Governmental responses to these situations, in many cases triggered by severe electricity crises in the early 1990's, have resulted in a wide range of measures: from controlled participation by the private power sector in Costa Rica, to total openness and deregulation in Guatemala and El Salvador.

Given the modest size of the electricity grid, it is generally recommended that project sizes do not exceed 70 MW. This creates a niche for renewable energy generation including sugar cane cogeneration. Some of the biomass-to-energy projects as well as some of the thermal projects have been instrumental in focusing discussions on the issue of project financing. Annual investment in private power in the region over the last couple of years has reached about US$300 million, a figure which is expected to increase as institutional mechanisms become more accessible, straight forward and concise in each country. Identified sugar mill cogeneration projects in the region account for approximately 15% of that sum, while sugar mill cogeneration accounts for about 4% of the total generation mix in the region. Most of this investment has taken place in Guatemala.

There is some experience of interconnected sugar mill projects in Central America. The most successful projects have been those using supplementary thermal fuels for off-season operation, and some smaller projects which export surplus power during the crushing season.

Over the past decade, there have been several attempts to assess the potential for sugarcane cogeneration in the Central Amercian countries. Preliminary estimates based on a sample of sugarcane processing facilities, with very traditional and inefficient machinery (generating 10-20 kWh/ton of crushed cane) show that the Central American mills may be

currently generating around 420 million kWh. In the hypothetical case of boosting the generating capacity of the existing mills to 60 kWh/ton, the region's generating capacity could be increased to about 1,680 million kWh. These figures show that the sector could supply up to 8-10% of the region's electricity demand (a figure that does not include additional power which could be generated by using other supplementary of biomass fuels during the off-season).

The country studies conducted by BUN-CA in 1997 show that at this point in time, only about 15% of the sugar mills in the region are exporting surplus electricity. Guatemala is clearly in the lead in this respect, having added about 100 MW of installed capacity which supplies about 4% of the country's electricity demand, and using thermal fuels for off-season generation. This makes their projects highly competitive in the power markets (another 70 MW is due to come on line in 1998). The results presented in the different country studies show that in the short to medium term, the sugar mills in the region could add up to 250 MW of capacity, of which 40% has been identified to be at different stages of the project deveopment process.

This study highlights a number of issues:

- In the short term, the market potential of sugarcane cogenerated power is relatively high, with a potential development of up to 200 MW of installed capacity, while a much higher figure is likely in the long term.

- Utility companies have been the traditional markets for power, and sugar industry has not looked at other potential customers.

- The use of new technology, both in the processing and the power sides of the emerging business, has been incremental, with boiler expansion increasing from the lower (200-250 psi) to medium (400-600 psi) pressures. This increase in pressure reduces the risks associated with the upgrading to the higher and more efficient operating pressures (800-900 psi).

- Investment levels, and more importantly, the instruments used to finance projects, are still very traditional from the point of view of corporate guarantee financing.

- Power contracts signed between sugar mills and utility companies do not accurately reflect the conditions faced by a cogeneration developer, since most of the risk is with the sugar mill.

- There is a lack of integrated discussion in the sector at the regional level on electricity as a new and key product for the industry.

## RESUMEN EJECUTIVO

Este estudio pretende presentar y discutir la producción de azúcar en seis países de América Central desde la perspectiva de la contribución potencial del sector a la generación eléctrica. En un menor grado, también busca discutir aspectos de la sustentabilidad del mercado para la producción azucarera de la región.

La industria azucarera ha sido durante largo tiempo un sector clave de las economías centroamericanas. En la mayoría de los países, una tercera parte de los ingresos generados por la agricultura proviene de la caña de azúcar. Unas 350,000 hectáreas están sembradas con este cultivo, convirtiendo a este sector en uno de los principales usuarios de la tierra agrícola en la región. También es una de las principales fuentes de trabajo, pues se le atribuyen unos 200,000 empleos directos.

Guatemala es el principal productor azucarero, con un 52% de la producción total. Le siguen Costa Rica y El Salvador con 12,5% cada uno, Nicaragua con el 10,7%, Honduras con el 8% y Panamá con un 4,6%. Además es probable que si la tendencia a poner fin a los subsidios se mantiene durante los próximos años, el precio se ajustará a niveles superiores a los de los precios recientes en el mercado internacional.

La industria azucarera centroamericana está compuesta por 61 ingenios con una capacidad total de molienda de cerca de 200,000 TCD (Toneladas de Caña al Día). La capacidad promedio de los ingenios varía entre 3,000 y 3,500 TCD, aunque los rangos de capacidad nominal varían enormemente, alrededor de 600 TCD en los ingenios pequeños, a más de 15,000 TCD en las plantas más grandes. En conjunto, estos ingenios procesan más de 28 millones de toneladas de caña al año, produciendo cerca de 2,5 millones de toneladas métricas de azúcar y más de un millón de toneladas de melaza, siendo la temporada promedio de molienda de 160 días.

Las tasas de productividad varían de un país al otro. Guatemala tiene la tasa más alta: produce cerca de 81 toneladas de caña por hectárea mientras que Panamá tiene la más baja, alrededor de 60 toneladas de caña por hectárea. La mayoría de los países muestra un rendimiento normalmente entre 94 y 104 kilogramos de azúcar por tonelada de caña procesada.

En relación a la producción de bagazo, es necesario profundizar los estudios al respecto. Se estima que entre el 30 y el 32% de la caña procesada se convierte en bagazo con un contenido de humedad de cerca del 50%, produciendo un total de casi 8,4 millones de toneladas de bagazo, el cual se utiliza sobre todo para alimentar las calderas con el fin de autogenerar la energía térmica y eléctrica requerida en el proceso de elaboración del azúcar.

Puesto que el bagazo ha sido un combustible prácticamente gratuito (o al menos se le consideraba así), esta agroindustria no ha tenido tradicionalmente ningún incentivo para aprovechar eficientemente el bagazo como combustible o fuente energética

económicamente rentable. Por ello, la mayoría de los ingenios usan calderas de baja presión y turbogeneradores de un solo ciclo de baja eficiencia, que consumen en promedio de tres a cuatro veces más bagazo para producir un kWh, en comparación con ingenios de otras latitudes. Por ejemplo, dependiendo de la capacidad y edad de la tecnología instalada; así como la competitividad del mercado energético, los diferentes informes nacionales preparados por BUN-CA, en 1997 muestran valores que van de 460 a 580 kilogramos de vapor por tonelada de caña procesada, y valores que varían entre 10 y 40 kilogramos de vapor por kWh generado.

Basados en respuestas individuales a los factores que afectan el desarrollo de la industria procesadora de caña, diferentes empresas del sector azucarero han comenzado a estudiar el potencial de la cogeneración eléctrica como un nuevo negocio. En casi todos los países de la región hay ejemplos de ingenios que están evaluando o ejecutando proyectos muy diversos para interconectarse con las líneas de transmisión para intercambiar o vender los excedentes de electricidad durante los períodos de zafra y post zafra. Algunos de estos proyectos implican una inversión sustancial en la readecuación de la turbomaquinaria, mientras que otros involucran pequeños excedentes de electricidad producidos con ciclos de generación muy simples por ejemplo sin condensación y a baja presión.

Como promedio uno de cada dos centroamericanos no tiene acceso a la red eléctrica y existe una gran disparidad en términos de consumo per cápita, que va desde 274 kWh en Nicaragua a cerca de 1,300 kWh en Costa Rica. La capacidad de generación eléctrica en la región deberá que duplicarse prácticamente dentro de los próximos seis a siete años, exigiendo un aumento de cerca de 3,000 MW en la capacidad de generación instalada. La demanda de potencia y energía en la región ronda los 4,500 MW y 20,000 GWh respectivamente.

Las respuestas gubernamentales a estas situaciones, a menudo detonadas por las severas crisis por faltante de electricidad a comienzos de la década de 1990, han incluido una amplia gama de medidas, desde la participación controlada del sector privado en Costa Rica a la apertura total y desregulación en el resto de los países.

Por razones de confiabilidad, se recomienda generalmente que el tamaño de los proyectos de cogeneración no exceda los 70 MW. Esto crea un nicho para la generación renovable de energía, incluyendo la cogeneración a base de bagazo. Algunos de los proyectos de generación energética a base de biomasa, así como algunos de los proyectos de energía térmica, han desempeñado un papel clave al enfocar la atención en el tema de financiamiento de proyectos. La inversión anual en la generación privada de electricidad en la región a lo largo de los últimos años se ha estimado en unos US$ 300 millones, una cifra que se espera crezca conforme los mecanismos institucionales y financieros se tornen más accesibles y eficientes en cada país. Los proyectos de cogeneración azucarera que se han identificado en la región corresponden a cerca del 15% de esa inversión anual. En términos de producción eléctrica, la cogeneración por caña corresponde a cerca del cuatro por ciento del total en la región, donde la mayoría de las inversiones se han realizado en Guatemala.

Los proyectos más exitosos han sido aquellos que utilizan combustibles térmicos suplementarios para su operación en temporada baja (fuera de zafra) y algunos proyectos más pequeños que exportan sus excedentes durante la molienda.

A lo largo del último decenio ha habido varios intentos de evaluar el potencial para la cogeneración en la agroindustria de la caña en Centro América. Cálculos preliminares basados en una muestra de las instalaciones de procesamiento de caña, con maquinaria muy tradicional e ineficiente (que genera entre 10 y 20 kWh por tonelada de caña molida), muestran que los ingenios centroamericanos están generando en la actualidad cerca de 420 GWh. Estas cifras señalan que el sector podría suplir entre el 8 y el 10% de la demanda de energía eléctrica de la región, cifra que no toma en cuenta la electricidad que podría generarse utilizando combustibles suplementarios al bagazo durante la temporada fuera de zafra.

Los estudios realizados por BUN-CA en los seis países centroamericanos en 1997 muestran que en la actualidad sólo cerca del 15% de los ingenios de la región están exportando excedentes eléctricos. Guatemala está claramente a la cabeza en este aspecto, tras haber agregado cerca de 100 MW de capacidad instalada que suministran cerca del cuatro por ciento de la demanda nacional de electricidad en ese país. Esto hace que estos proyectos resulten sumamente competitivos en el mercado energético, y se espera que otros 70 MW estén disponibles en 1998. Los resultados de cada país muestran que en el corto a mediano plazo los ingenios de la región podrían agregar hasta 250 MW de capacidad, donde cerca del 40% de esa capacidad se encuentra en alguna de las etapas del proceso de desarrollo del proyecto.

Finalmente, la Iniciativa Centroamericana resalta varios aspectos importantes:

- A corto plazo, el potencial de mercado de la electricidad cogenerada en la agroindustria de la caña de azúcar es relativamente alto, con un desarrollo potencial de hasta 200 MW de capacidad instalada, mientras que la cifra en el largo plazo puede ser mucho más alta.

- Las empresas de servicios eléctricos han sido el mercado tradicional para la venta de la energía excedente y la industria azucarera no ha considerado a otros clientes potenciales, como serían las industrias de alto consumo eléctrico.

- El uso de nuevas tecnologías, tanto en el terreno del procesamiento de la caña de azúcar como de la cogeneración, se ha dado en incrementos, con una expansión de las calderas que aumenta de las presiones bajas (200 – 250 psi) a las medianas (400- 600 psi), sin que aún no exista una perspectiva definida de que se vayan a realizar inversiones en la instalación de calderas a presiones más altas y eficientes (800 – 900 psi).

- Los niveles de inversión y lo que es más importante, los instrumentos utilizados para financiar proyectos, siguen siendo muy tradicionales donde generalmente se utiliza el esquema de financiamiento corporativo con garantías reales.

- Los contratos energéticos firmados entre los ingenios y las empresas de servicios eléctricos no reflejan correctamente las condiciones que enfrenta la parte de cogeneración eléctrica del ingenio, puesto que la mayoría del riesgo recae sobre el procesamiento del azúcar.

- El sector no ha comenzado todavía a discutir de manera integral a nivel regional la generación de la electricidad como un nuevo producto clave para la industria azucarera.

# I. The Context of the Sugarcane Industry in Central America

Central America is currently undergoing a process of transformation that encompasses production, competitiveness, economic development, profound social changes and environmental concerns that are reflected in a new set of sustainable development paradigms. Regional trends reflect not only transformations in the social fabric, but also in the roles that different economic sectors play as agents of transformation. Within this process, traditional sectors of the economy, such as agriculture, face many challenges to become more competitive. At the same time they must comply with new environmental regulations and allow for greater multisectoral participation, a key element to assure equality in socio-economic development.

Since the sugar industry has long been a pivotal sector of the economies of the different Central American countries, this study on diversification trends and the potential for sugar cane cogeneration in the region is timely. To introduce the topic, Table 1 presents an overview of the main socio-economic indicators in six Central American countries.

## Table 1:Central American Indicators

| Country | Area (km2) | Population (million) | Population Growth Rate (%) | GDP (billion US$) (1995) | GDP Growth (%) (95) | Infla-tion Rate (%) |
|---|---|---|---|---|---|---|
| **Guatemala** | **108,890** | **10.6** | **2.7** | **14.0** | **4.9** | **10.4** |
| **Honduras** | **112,090** | **5.5** | **2.5** | **4.1** | **3.6** | **30** |
| **El Salvador** | **21,040** | **5.9** | **2.0** | **9.3** | **6.0** | **10** |
| **Nicaragua** | **129,490** | **4.3** | **2.8** | **2.5** | **4.2** | **12** |
| **Costa Rica** | **51,100** | **3.5** | **1.8** | **9.0** | **4.5*** | **10** |
| **Panama** | **78,200** | **2.8** | **1.4** | **8.0** | **3.5** | **3** |
| **TOTAL** | **500,810** | **32,6** | | **46,9** | | |

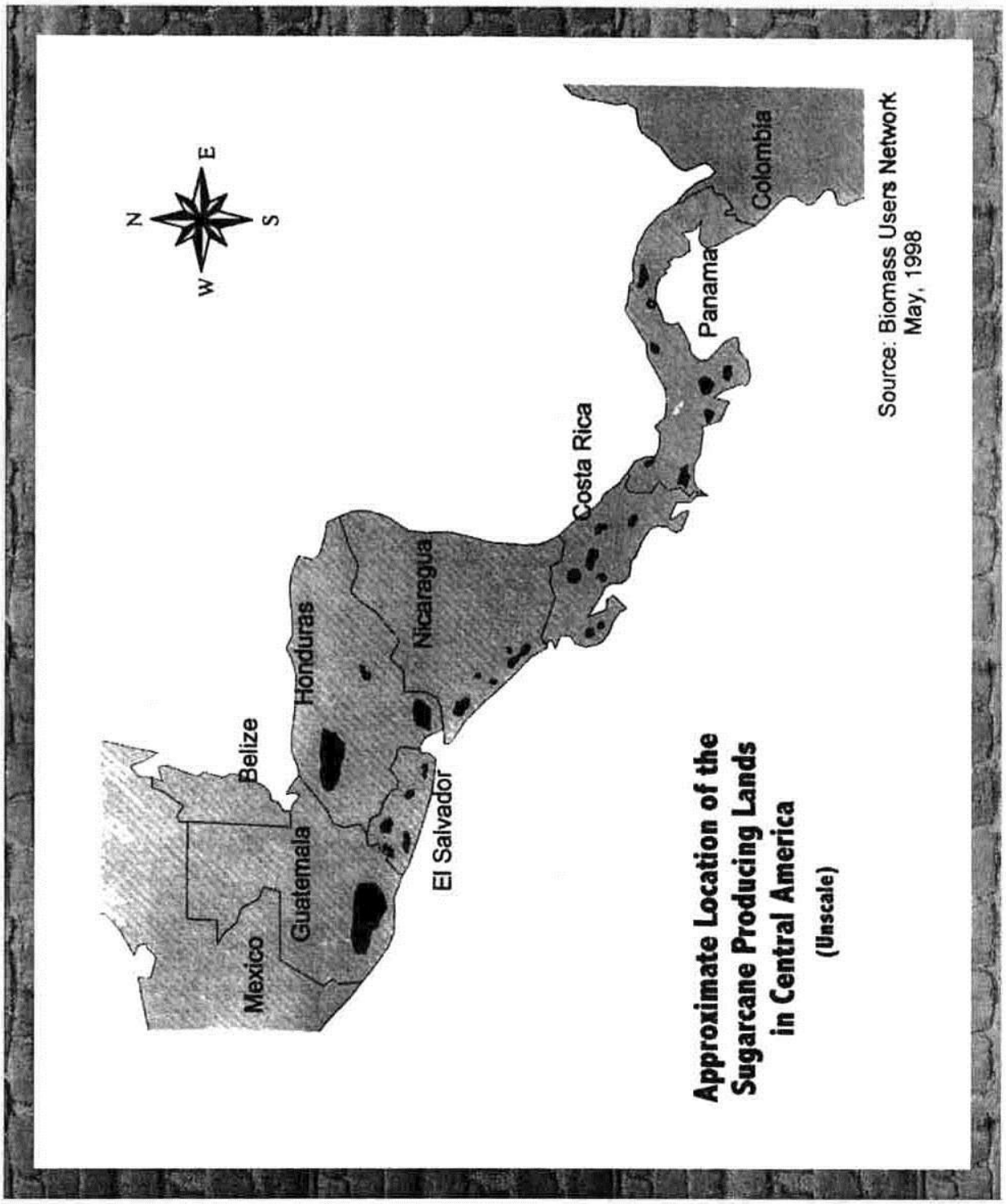
Sources: 1. KPMG Latin America Country Profiles at http://www.latinamerica.kpmg.com
2. Fundesa, Guatemala, 1996
3. SIECA, Sistema de Integración Regional, 1996

* Costa Rican GDP growth is reported as an average for the period 90-95.

Central America currently produces more than 2.5 million metric tones of sugar annually. The Map in the next page shows the different locations of agricultural lands dedicated to sugarcane production in Central America.

The region's leading producer is Guatemala, with 52% of the area's total production, followed by Costa Rica and El Salvador with 12.5% each, Nicaragua 10.7%, Honduras 8%, and Panama with 4.6%. In terms of exports and internal consumption of sugarcane production, Table 2 clearly shows that Guatemala is the only country in which sugar is primarily an export commodity, with exports accounting for over 70% of the country's

sugarcane production. In the rest of the Central American countries, sugar production is still mainly geared to domestic consumption, ranging from 58% in Costa Rica to as much as 90% in Honduras.




interventionist policies aimed at ensuring food security, price stability, economic

development, fiscal gains, etc. National sugar policies -- as well as external market prices and stability of quotas-- have contributed to the development of a very specific market, where the trend towards expanded production can be clearly seen.

The traditional business-oriented approach shown by this economic sector in Central America, fuelled by a new process of regional integration and based on an alliance around issues and products that are critical to the region's competitiveness, has clearly impelled the sugar industry to strengthen private sector participation and above all to engage in lobbying efforts in relation to the international sugar markets issue, which is currently on the discussion agenda of the World Trade Organization. There is a general perception in Central America that if the trend to eliminate subsidies continues over the next few years, the price would adjust to levels that are superior to recent international market prices.

Particular attention should be paid to the Guatemalan sugar sector, which is actively seeking to increase its access to international markets, and where ownership of sugar-producing land and processing capacity is concentrated in a few companies. Meanwhile, the other countries are at different stages of the process to restructure this sector. In Costa Rica, for example, there are major discussions about quotas among regional producers (Central Valley vs. Pacific lowland producers) as well as considerable pressure on lands for production; in Nicaragua a highly conflictive privatization process is under way, while in Panama, the privatization process is only just beginning. In El Salvador, sugar-processing facilities have recently been privatized, though much of the agricultural land for sugar production remains in the hands of cooperatives and "colonos" (settlers).

The above underscores the fact that the situation in the region's sugar sector is far from uniform, and that national or local actors are still analyzing and debating the best route to follow in their production and above all, defining their positions in the international trade forums.

Aside from the varying macro-market conditions it is also important to note that there are still major differences in land tenure patterns in the different countries. In El Salvador, for example, a large proportion of sugar-producing land is agriculturally exploited by cooperatives, whereas in Guatemala sugar production is concentrated in the hands of a few private companies.

Sugar is still one of the most important crops in Central America, making a significant contribution to the Gross Domestic Product (GDP), of each country. For example in Guatemala, sugar represents about 16% of all exports, and acounts for 29% of leading agricultural exports, in second place after coffee. In percentage terms, the situation is similar in Costa Rica, Nicaragua and El Salvador. However, in Honduras and Panama, the situation is very different since this crop makes a greater contributrion to the domestic economy. In any case, in most Central American countries, sugarcane production accounts for about one-third of agriculturally generated revenues.

The importance of this sector is not only reflected in its economic contribution to the

economy as a whole, but also in its impact on employment. The sugar industry employs a large work force and provides an estimated 200,000 direct jobs at regional level (benefiting up to one million people, including workers' families, and representing almost 3% of the Central American population), both during the harvest (zafra) and off-harvest seasons. It is difficult to determine the number of indirect jobs created by the sector, but it can be argued that the figure is much higher than the number of direct jobs. These statistics clearly reflect the social importance of this crop in Central America. Work force migration during the "zafra" has become an important issue in many countries, particularly in Costa Rica, which relies heavily on Nicaraguan labor to harvest its sugarcane crop.

The sugar sector currently cultivates around 350,000 hectares of land, making it one of the main users of agricultural land in the region. During the past few years, both Guatemala and Nicaragua have increased the area of land planted with sugar at a very fast rate, whereas in other countries, the expansion of sugar plantations has proceeded at a much slower pace. It is important to emphasize that since land used for sugar production is usually concentrated in certain areas of each country, major environmental and land use impacts are associated with this type of agriculture.

There are also pockets of small producers, "paneleros" or "trapiches", who are not integrated into the mainstream of the sugarcane industry and who continue to use very old and traditional methods to manufacture raw brown sugar, which is basically traded in small domestic markets.

In this context, sugar diversification programs and sugar cogeneration will need to be approached from the standpoint of the sector's projected transformation in the coming years, and also from the standpoint of the relative competitive value that other sugar derived products, such as power generation, can add to this industry. To date, in Central America, most of the discussion on diversification has focused on cogeneration, with very little discussion on diversification in the sector as a whole, as is beginning to occur in other latitudes, especially in countries which do not receive any form of protection or import preferences.

Besides, in the Central American region, there are signs that some small sugar producers are looking at the economic sustainability of their activities (mostly "paneleros" or small-scale producers). They have already begun to discuss this issue and are moving into new market niches and agricultural diversification schemes.

This study aims to present and discuss Central American Sugar Production mainly from the perspective of the sector's potential contribution to electricity generation, and, to a lesser extent, in relation to discussions on sustainable markets for the region's sugar production.

## II. Central American Sugarcane Processing Overview

Central America's sugarcane industry consists of 61 factories with a total daily crushing

capacity of around 200,000 tons of cane per day. The average size of the factories is 3,000-3,500 TCD (Tons of Cane per Day), though capacity varies tremendously from the 600 or so TCD in the smaller mills, to the 15,000 TCD crushed by the largest processing plants. Together, these facilities process over 26 million tons of cane per year, producing about 2.6 million tons of sugar and over 1 million tons of molasses (with an average crushing season of 160 days).

Productivity rates vary considerably from one country to another. Guatemala boasts the highest productivity rates in the region, producing around 81 tons of cane/ hectare, while Panama has the lowest rate, producing about 60 tons of cane/hectare. Most of the other countries average 66-70 tons of cane/hectare. Productivity at the sugar mills also varies greatly from one plant to another, depending on the processing methods and the variety of cane used (percentage of fiber). Average figures range from 94 to 104 kg of sugar per ton of cane processed. Table 2 shows the main statistics relating to Sugar Cane Production in Central America.

## Table 2: Central American Sugarcane Production Statistics

| Country | Land in Production (ha) | # of sugar mills | Total Cane Processed (million Tons) | Sugar Production (Ton) | Daily Crushing Cap. (TCD) | % Export |
|---|---|---|---|---|---|---|
| Guatemala | **165,000** | **17** | **14** | **1,275,257** | **87,000** | **71** |
| Honduras | **N/A.** | **8** | **N/A.** | **245,289** | **26,000** | **6** |
| El Salvador | **47,000** | **10** | **3.4** | **346,387** | **27,000** | **34** |
| Nicaragua | **45,000** | **6** | **3.5** | **306,363** | **26,000** | **43** |
| Costa Rica | **44,000** | **16** | **3.2** | **327,164** | **30.000** | **48** |
| Panama | **35,000** | **4** | **1.5** | **140,000** | **N/A.** | **37** |
| Total | **336,000** | **61** | **25,6** | **2,640,460** | **196,000** | |

Sources:
1. AICA, Central American Sugar Production Statistics 94-95
2. BUN-CA, Central American Sugar Diversification Initiative, Country Reports, 1997
3. SIECA, Central American Production Statistics, 1996

Although the data on bagasse production is somewhat erratic, an estimated 30-32% of the cane processed becomes bagasse at around 50% moisture content, producing a total of around 8.4 million tons of bagasse, which is mainly used as boiler feedstock for power and process heat generation in the sugar mills. There are no definitive figures on the amounts of excess bagasse produced by Central American mills and only a handful of mills in the region implement controls to evaluate bagasse availability and assess feedstock supply-demand for this biomass fuel. Table 3 shows bagasse production in the different countries.

## Table 3: Central American Bagasse Production for the 95-96 "Zafra"

| Country | Bagasse Production (Tons) |
|---|---|
| Guatemala | **4,200,000** |
| Honduras | **1,260,000** |
| El Salvador | **1,053,800** |
| Nicaragua | **1,025,226** |
| Costa Rica[1] | **1,000,000** |
| Panama | **454,943** |
| Total | **8,993,969** |

Sources: 1. BUN-CA, Central American Sugar Diversification Initiative, Country Reports, 1997.

Since bagasse has been a virtually cost-free fuel (or is perceived as such), local mills have so far had no incentive to use the energy from bagasse more efficiently. Consequently, sugar mills use low pressure boilers and low efficiency single cycle turbogenerators, which require three to four times the amount of bagasse to produce a kWh, compared with the more efficient sugar factories in which both the *steam consumed by each ton of cane processed*, as well as the *steam consumption by kWh generated*, is lower.

It is difficult to give average figures for the parameters described above, which would illustrate the scale of steam consumption and electricity generation capacity at sugar mills. Depending on the size of the mill, the age of the refining technology, the competitiveness of the firms, the different country reports prepared by BUN-CA show values ranging from 460-580 kg steam/ ton of cane processed and from 10-40 kg steam/kWh generated.

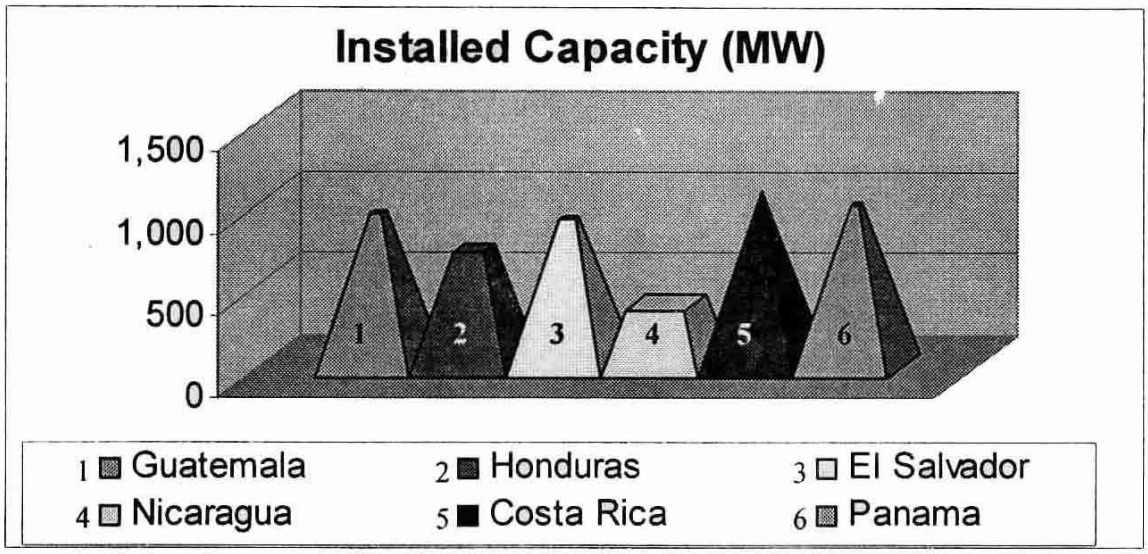
There are examples of individual mills that are striving to improve efficiency indicators in relation to the effective use of available bagasse. Some mills have taken a different approach to this issue, prompted by a set of external and internal "push and pull" effects, such as competition, or responsiveness to a potential new product, such as the export of electricity, for example. In this respect, there are three mills which have experimented with using bagasse for board manufacturing, though prevailing market trends in this sector have forced two of them out of this business (due to market penetration by other producers of this competitive industrial product and their better management of market parameters).

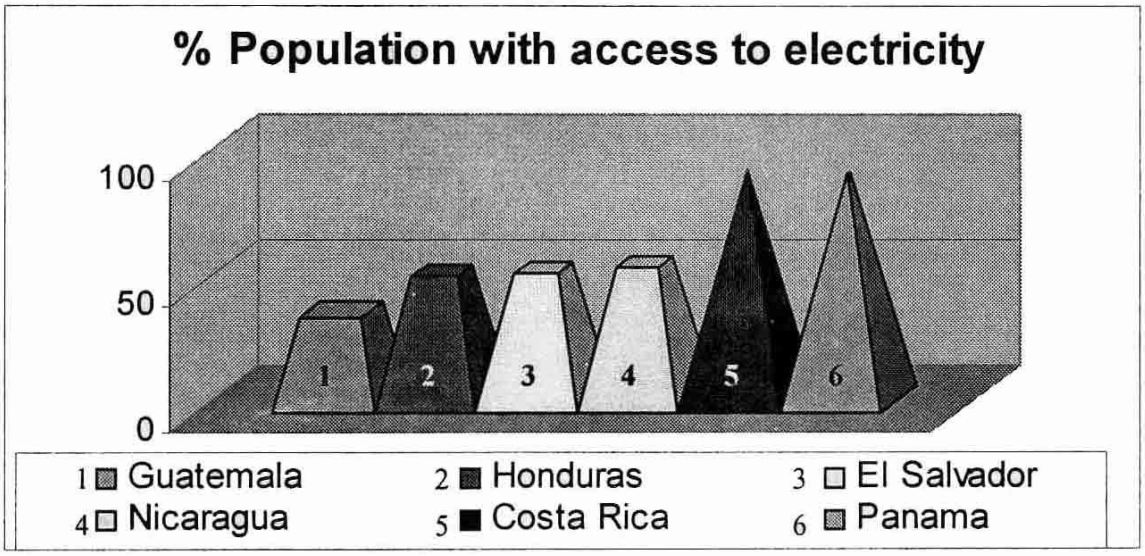
Based on individual responses to the factors affecting the development of the sugarcane processing industry, various mills (rather than local or regional organizations), have begun looking at the potential of power cogeneration for export and as a new strategic business for the sugar industry. In each one of the countries there are examples of mills implementing projects or evaluating project proposals of a very diverse nature for interconnection with transmission lines, in order to exchange excess power and energy

[1] Information for Costa Rica is estimated based on total cane processed and a 31% conversion from cane to bagasse. El Salvador and Guatemala are the only countries for which there is available information on bagasse excess ranging from 10-12%.

during off-season periods. Some of these projects require a substantial investment in revamping the mills, while others may simply involve generating small surpluses from very simple generation type cycles (non-condensing, low pressures, etc.).

The sugar industry's growing participation in the energy sector of various countries is discussed in a subsequent section of this Report. It should be noted that the country reports of the BUN-CA Sugar Diversification Initiative provide detailed information on existing projects as well as the development of identified projects at some point in the pre-investment cycle.




## III. The Central American Energy Context

The Central American countries are undergoing rapid and profound institutional transformations, including the restructuring of their respective energy sectors. At the same

time, a relatively high rate of population growth and integration into economic development processes have meant that energy demands throughout the region are increasing at rates that exceed 7-10% per year, both in terms of power and energy.

Power and energy production capacities in the region will need to almost double within the next 6-7 years, requiring the addition of over 3,000 MW of installed power. Current installed power and electricity demands in Central America are of the order of 4,500 MW and 20,000 GWh, respectively.

It should be noted that, on average, one out of every two Central Americans does not have access to power services from the grid. Moreover, there is a high level of disparity between countries in terms of per capita consumption, ranging from as low as 274 kWh per capita in Nicaragua, to about 1300 kWh per capita in Costa Rica. The task of responding to this growth in demand and other social factors linked to the development of the countries in the region, is not only a technical challenge, but also an institutional one. But above all, it is an investment challenge for countries with emerging stable economies, and which in some cases are recovering from recent armed conflicts. Table 4 presents comparative data on energy statistics related to the electricity subsector in the different countries in the region.

## Table 4: Central American Energy Statistics

| Country | Installed Capacity (MW) | Electricity Demand (GWh) | Per Capita Electricity Consumption (kWh/person) | % Population with access to electricity (approx.) |
|---|---|---|---|---|
| **Guatemala** | **950** | **3,500** | **281** | **36** |
| **Honduras** | **721** | **3,100** | **350** | **51** |
| **El Salvador** | **910** | **3,250** | **479** | **52** |
| **Nicaragua** | **393** | **2,000** | **271** | **54** |
| **Costa Rica** | **1075** | **4,200** | **1,271** | **91** |
| **Panama** | **1000** | **3,900** | **1,064** | **90** |
| **Total** | **5,049** | **19,950** | | |

Sources:
1. U.S. AID, Environmental Markets in Central America, May 1997 (adjusted for transmission losses)
2. BUN-CA, Central American Sugar Diversification Initiative, Country Profiles, 1997.

As mentioned above, the different countries in the region face very rapid growth rates in electricity consumption, increasing at an average rate of 6-7 % per year. This means that most of the countries will need to implement power capacities in the order of about 1,500 MW by the year 2000. Table 5 shows the estimated power needs of the different countries.

## Table 5: Electricity Peak Generating Capacity Needs in Central America (MW)

| Country | Current | Year 2000 | Year 2005 |
|---|---|---|---|
| **Guatemala** | **0** | **247** | **507** |
| **Honduras** | **100** | **271** | **320** |
| **El Salvador** | **0** | **324** | **550** |
| **Nicaragua** | **9** | **72** | **156** |
| **Costa Rica** | **0** | **318** | **625** |
| **Panama** | **50** | **330** | **470** |
| **TOTAL** | **159** | **1,562** | **2,628** |

Sources: 1. Hagler Bailly, Inc. Environmental Markets in Central America. USAID, May, 1997 (based on McGraw Hill International Power Quarterly).
2. BUN-CA, C.A. Sugar Diversification Initiative, Country Profiles, 1997.

Governmental responses to these situations, in many cases triggered by severe electricity crises in the early 90's, have included a wide range of measures, from experiments with limited private sector participation in the power sector in Costa Rica, to policies of total openness and deregulation in Guatemala and El Salvador (where open market competition has been stimulated by recent legislation). Other countries are still debating this issue and trying to reach political consensus on how best to transform their electricity sector. However, one common element in each case has been the relatively high speed of change and the inability of institutions and regulatory bodies to respond promptly with stable and transparent processes.

Although governments have responded to the restructuring of the sector, there are broad areas of energy policy which have not been addressed and which form part of the larger picture. Issues such as rural energy services, thermal vs. renewable energy generation and the environmental aspects of energy generation, have not yet been fully incorporated into the energy policies that are emerging in the region. Aside from the electricity sector, which is the focus of this study, fuelwood is still the main energy source in Central America and will be for years to come, exerting a lot of pressure on local environments.

The dependency of the region's countries on thermal fuel, with the possible exception of Guatemala, is another aspect of the energy picture. It is evident that the growth rate and infrastructure requirements for imports, processing and distribution are also very substantial. In most Central American countries, this component is already deregulated

with open market competition. In most countries, there have been rapid short term additions of thermal plants Although the region must live with the installation of this type of generation to ensure a flexible and responsive system of power delivery, it must be recognized that dependence on foreign currency and environmental considerations are also becoming part of policy-making in the sector.

Despite the fact that power generation from renewable sources of energy faces competition from other types of power generation, it does have some competitive advantages. There is an abundant renewable energy potential in the region that far exceeds the anticipated 2,500 MW required in the next 10 years. Aggregated figures can be summarized as potentials of about 4,000 MW of hydro, 400 MW of geothermal, 200 MW from wind power plants. As this study shows, there is also a significant potential for sugarcane cogeneration, with a capacity of about 300 MW currently under construction or development (Guatemala has about 220 MW, El Salvador about 15 MW, Honduras 10 MW and Nicaragua 30 MW).

Renewable energy projects in Central America are likely to be cost-effective due to the high cost of competing fossil fuel resources. If compared with standard costs for generation at base load conditions, fossil fuel generation costs range from $0.052 per kWh to over $0.065 per kWh. Renewable energy projects operating in the region show an average cost of around $0.05 per kWh. Looking at the intermediate load supply, the cost of fossil fuel generation reaches up to $0.084 per kWh, e.g. thermal plants already operational in Guatemala, while some of the operational renewable energy projects would cost around $0.063 per kWh. This comparison clearly shows that renewable energy power generation is now competitive in the Central Ameircan power markets.

The modest size and poor development of the electricity grids make them well suited to small scale energy projects (average system size of firm transmission capacity is 700 MW). For reasons of reliability, it is usually recommended that projects do not exceed 70 MW, thereby creating a niche for renewable energy generation, including sugarcane cogeneration.

This scenario may be substantially altered by the ongoing Central American Electric Interconnection Project (known as SIEPAC), a project to develop a stronger and more competitive regional market for electricity, with the objective of improving reliability, quality and continuity of service. Renewable energy initiatives in the region would eventually be required to adjust to this new market and it is possible that projects will have to be concentrated in certain key geographical points in order to be strategically placed for effective delivery in this eventual regional interconnection.

Central America is now engaged in a process to reform the power sector, and most countries in the region have already signed contracts with independent power producers. These advances are stimulating investment in the sector, and the countries with most comprehensive reforms are Guatemala, El Salvador and Panama. However, the ongoing reform process has also introduced a certain element of uncertainty with respect to resolving contract disputes, setting new power tariffs, and implementing resolutions. This uncertainty is felt particularly by renewable energy project developers, since the

structuring of these types of projects differs from conventional ones. Tables 6 and 7 provide an overview of the status of electricity sector reforms and private sector participation in the Central American countries.

## Table 6: Status of Power Sector Privatization in Central America

| Country | Electric Utility | Current Status | Ongoing Activities |
|---|---|---|---|
| Guatemala | Instituto Nacional de Electrificación (INDE), Empresa Eléctrica de Guatemala (EEGSA) | Law 93-96 unbundled power sector, still state held, creation of Energy Commission, By-laws published, creates wholesale market | Selling of EEGSA Thermal Assets, Registration of new distribution companies, formalize the Wholesale Market Authority |
| Honduras | Empresa Nacional de Energía Eléctrica (ENEE) | Privatization plans developed in 1994, but not fully implemented, creation of Energy Commission | Future actions not determined. Support from European Union for sector institutional Strengthening |
| El Salvador | Comisión Ejecutiva Hidroeléctrica del Río Lempa | Law unbundled power sector, still state owned, distribution companies are private | Ongoing studies to assess possible privatization |
| Nicaragua | Empresa Nacional de Energía Eléctrica (ENEL) | Law under development would unbundle the power sector | Future actions not determined |
| Costa Rica | Instituto Costarricense de Electricidad (ICE) | Corporatization proposed, facing heavy opposition | Continued state role likely, "corporatization" may be implemented |
| Panama | Instituto Nacional de Recursos Hidráulicos y Electrificación (IHRE) | Law would reorganize and partially privatized IHRE | Privatization is underway |

Sources:

1. Hagler Bailly, Inc. Environmental Markets in Central America. USAID, May, 1997 (based on McGraw Hill International Power Quarterly).
2. BUN-CA, Central American Sugar Diversification Initiative,

Country Profiles, 1997.

## Table 7: Private Sector Power Regulation in Central America

| Country | Regulatory Agency | Private Participation | Activities |
|---|---|---|---|
| Guatemala | Comisión Nacional de Energía Eléctrica established in 1997 | Private Power supplies 30% of total generation . Over 400 Mw expected IPP participation by 2010. Law fixes basis for competitive wholesale price. | Guarantee issues, transparency of asset selling in progress. Strong competition and lobbying from IPP's |
| Honduras | Comisión Supervisora de los Servicios Públicos, not clear the role of the Comisión de Energía established by the 1994 Law | Two recent private power closings. Private power bidding allowed under decree. | Ongoing IDB, EU projects to evaluate power sector deregulation |
| El Salvador | Superintendencia de Electricidad y Comunicaciones | Private power experience (thermal). Competition in the market is expected | Regulations should be in place during 1997 |
| Nicaragua | Office of Utility Regulation | Utility purchases allowed. Recent first private closing (thermal). Strong lobbying required | Law under consideration. Uncertain political negotiations |
| Costa Rica | Autoridad Reguladora de los Servicios Públicos (ARESEP) | Private power experience (renewable), limits IPP participation to 35% of capacity, subject to competitive bidding, support to BOT, BOOT joint ventures with private power. Detected slow down on PPA signing with the private sector | General Electricity Reform is under discussion and faces trade union and political opposition. |
| Panama | Ente Regulador de los Servicios Públicos | IPP allowed, recent PPA closures | - |

Sources:
1. Hagler Bailly, Inc. Environmental Markets in Central America. USAID, May, 1997 (based on McGraw Hill International Power Quarterly).
2. BUN-CA, Central American Sugar Diversification Initiative, Country Profiles, 1997.

Most of the traditionally state-owned utilities are being deregulated and in some cases are being divided into generation, transmission, and independent distribution companies that will either be privatized or will have to compete in the open market. The model developed in this process closely resembles the one used in several South American countries, though the conditions in Central America's power sector are very different -- there are no excess capacities but rather shrinking reserve margins, and also a very large under-served population especially in rural areas. From the point of view of renewable energy development, a glance at the different legislations clearly shows that a number of specific Sustainable Development Policy Instruments have not been utilized in this rapid transformation process, causing a rapid and increasing dependency on thermal plant expansion.

The above suggests that most energy policy makers are focused on getting the private sector to invest quickly in the sector, and have therefore taken a proactive role in this area. Some of the activities are related to: defining the contractual aspects of power purchase agreements (a matter of outmost importance for biomass to energy projects), alternative financial guarantees for emerging government-controlled companies, finding new investors (especially those interested in innovative mechanisms such as project financing and balance sheet financing).

The participation of the private power sector in Central America, at least from the financial perspective, has been very important and executed projects have relied mainly on the fact that financing has been accomplished by having relatively high debt-equity ratios, and that external (extra- regional) financing sources have, on average, accounted for 2/3 of the capital flows (due to limited local financial and stock mechanisms). It is interesting to note that some of the biomass-to-energy projects as well as some of the thermal projects have been instrumental in focusing discussions on project financing . Annual investment in private power in the region over the last couple of years has reached about US$ 300 million, a figure that is expected to continue increasing as mechanisms become clearer, more straight forward and concise in each country. Identified sugar mill cogeneration projects in the region account for approximately 15% of that figure, and sugar mill cogeneration has a share of about 4% of the total generation mix in the region, with most of this investment having taken place in Guatemala.

There is some experience of interconnected sugar mill projects in Central America, the most successful projects being those that are using supplementary thermal fuels for off-season operation, and other smaller projects which export surplus power during the crushing season. The pipeline project which was reviewed in the region shows a mixed record of successful and unsuccessful projects, based on comments received both from sugar mill managers and utility dispatchers. This is probably due to inadequate definition of project operations and controls which are necessary to properly structure power purchasing contracts.

# IV. Potential for Sugarcane Cogeneration

Given that there is a need for urgent power and energy in all the region's countries, and that the sugar sector has both the experience and the capacity to generate and export power into the grid, why are we not seeing full development of this type of project?

There have been several attempts over the last ten years to assess the potential for sugar cogeneration in the Central American countries. Several studies have been carried out in an attempt to advance the technology and devise different mechanisms to finance cogeneration and the export of power in the region.

Preliminary estimates, based on a sample of sugarcane processing facilities with very traditional and inefficient machinery (generating 10-20 kWh/ton of crushed cane), indicate that the Central American mills may be currently generating approximately 420 million kWh. In the hypothetical case that the generating capacity of existing mills could be boosted to 60 kWh/ ton, this could increase generation to about 1,680 million kWh. These numbers indicate that in general, the sector could supply 8-10% of the electricity demand in the region (without including the additional power that mills could generate using other supplementary thermal or biomass fuels during the off-season). Although this scenario is highly improbable, it should nevertheless persuade sugar sector policy makers that cogeneration should not be a project for individual sugar mills, but rather a strategic component of the sugarcane sector's policy and that there should be full participation in discussions on the incorporation of sugar mill cogeneration into the power sector.

The country studies conducted by BUN-CA show that at present only 15% of the sugar mills in the region are exporting surplus electricity. Guatemala has clearly taken the lead in this respect, having added about 100 MW of installed capacity which supplies about 4% of the country's electricity requirements, and using supplementary thermal fuels for off-season generation. This has made Guatemalan projects highly competitive in the power markets (with another 70 MW due to come on line by 1998). In the other countries, most projects are on a much smaller scale and also face different challenges: for example in Guatemala the mills began operating under a specially negotiated decree that offered a very attractive price for electricity, due to the short term addition requirements of the grid, whereas in the other countries, projects are grappling with the overall sector transformations currently under way.

The results presented in the different country studies indicate that short to medium term power supplies from sugar mills in the region could be increased to 250 MW, of which about 40% has been identified at different stages of the project development cycle.

Specific estimates for the power and energy inputs from sugar mills depend on the conditions and relative size of each facility, the specific characteristics of energy and steam usage, as well as the type of equipment used, the plant owners' commitment to transformation and investment, conditions of the PPA's available in each country, and capacity of the management team to develop a project.

Readers interested in specific country potential and identified projects currently under development should refer to the country studies prepared by BUN-CA as well as the information contained the comprehensive country reports produced by Winrock International, the Inter-American Development Bank, the U.S. Agency for International Development, and other sources mentioned in the Bibliography. Table 8 shows the projects that are currently operational or are being developed by different Central American sugar mills.

## Table 8: Sugarcane Cogeneration Projects identified under the Central American Sugar Cane Diversification Initiative

| Sugar Mill/Country | Mill Capacity (TCD average) | Project Size (MW average) | Status |
|---|---|---|---|
| Santa Ana / GUAT. | 9,492 | 30 | operational |
| Pantaleón/ GUAT. | 13,683 | 32.5 | operational |
| Concepción/ GUAT. | 6,845 | 22.5 | operational |
| La Unión/ GUAT. | 8,125 | 26 | operational |
| Magdalena/ GUAT. | 7,051 | 12.5 | operational |
| Madre Tierra/ GUAT. | 6,409 | 25 | operational |
| Yojoa / HOND. | 3,000 | 4 | first phase operational, prefes. |
| Santa Matilde / HOND. | 7,000 | 10 | prefeasibility |
| Central Progreso/ HOND. | 4,500 | 9 | pre-invest. in boiler |
| Central Izalco / ES | 8,500 | 20 | Pre investment |
| San Francisco / ES | 4,500 | 5 | Under construction |
| La Magdalena | 3,000 | 8 | Project Concept (DPR) |
| Victoria de Julio / NIC | 7,700 | 24 | Eng. Design, PPA negotiation. |
| San Antonio / NIC | 10,000 | 40 | Financing |
| Monte Rosa / NIC | 3,000 | 6 | Prefeasibility |
| Montelimar / NIC | 2,300 | 6 | Prefeasibility |
| Javier Guerra / NIC | 1,500 | 3 | Prefeasibility |
| CoopeVictoria / CR | 2,650 | 2 | Project Concept (DPR) |
| El Viejo / CR | 6,000 | 5 | Operational |
| Taboga / CR | 6,000 | 11 | Operational |
| Quebrada Azul / CR | 2,000 | 0.4 | implementing |
| Juan Vinas / CR | 1,800 | 5 | Feasibility |

Sources: 1. BUN-CA, Central American Sugar Diversification Initiative, Country Reports, 1997.

Comments:
1. The portfolio size of identified projects is 283 MW under some form of development.
2. Guatemalan mills are expanding off-season generation capacity, and investing in air pollution particulate controls.

It is clear that achieving this cogeneration potential would require a synergy not only of the technological advances required to make the sugar mill industry more efficient, but also a clearer set of participation rules that explicitly address the concerns of both sugar mill owners and utilities, an element that is vital to attract major investment for the revamping of this industry.

## V. The Context for Sugarcane Diversification in the Region

Sugarcane diversification has been traditionally considered from two basic perspectives: firstly, in terms of crop substitution and market diversification opportunities; and secondly, in terms of diversification based on energy and product investment options.

The first approach has been observed mainly in the area of intercropping potential, the development of new crops for domestic markets, the use of cane field waste as an energy resource (including power generation) and production of animal feeds. The aim is basically to consider and evaluate sustainable alternatives that could be more cost-effective than a very specialized product, which is subject to the uncertainties of the markets.

The second perspective has focused more on diversification and the development of new products from sugar cane and its residues, but with the sugar mills and highly specialized cropping patterns remaining as the key elements of this process. Within this approach, there are many well documented experiences: the use of cane tops and leaves for animal feed; production of yeast, citric acids, monosodium glutamate, ethanol, and other by-products from molasses; improved management and use of bagasse to produce electricity for export; and use of surplus bagasse for other industries (pulp and paper, furfural production, mushroom-growing medium, animal feed production, etc.).

More recently, a group of researchers, industry representatives and interested parties under the auspices of the United Nations University have called for a major shift in the comparative uses of sugarcane, to make sugar production more sustainable and at the same time more competitive, especially for smaller producers who do not receive quota benefits in the international markets.

The traditional approach to sugarcane production is based on the idea that it should be grown as a monoculture, with intensive use of chemical fertilizers and pesticides; that sugar as a main crop is cost-effective only if exported to wealthy nations that provide subsidies; that molasses should be exported as cheap raw materials or used only in alcohol production; processing results in large quantities of "vinasses" with a potential

environmental impact; bagasse is only used effectively as a low quality boiler fuel.

By contrast, the new approach is based on the notion that sugar production needs to be transformed into an Integrated Farming System, with a niche for organic sugarcane; that sugar should be used as a raw material for making more useful products (water softeners, detergents, bases for plastics, etc.); that bagasse as a major subproduct should be processed to obtain fibers for paper and lignin as a clean burning fuel; and finally, that processing wastes and crop residues should be used as effective mushroom and earthworm culture media.

These approaches are radical and different countries around the world, organizations within countries and specific interest groups, are reacting differently to these issues in the sugar industry.

Most of the concerns expressed in the context of Central America can be summarized by saying that the industry is still very much driven by sugar commodity exports and remains very defensive about maintaining, expanding or completely redesigning existing quotas and overall participation in the international market. Historically, this sector has responded timidly to new products with market potential (fibers, and even electricity sales; mainly due to the traditional family orientation of this business). It is also clear that the sector must comply with increasingly stringent environmental regulations, particularly in relation to water and air pollution.

In general, the debate on sugar diversification in Central America has not yet reached "critical mass" to make it a pressing issue for the sector and governmental authorities. Smaller groups, like the "paneleros" of Quiché in Guatemala, or the "trapiches" of Turrialba and San Ramón in Costa Rica, are confronted with the prospect of integral transformation in order to preserve their agricultural base and thereby maintain and improve their existing social and production conditions.

There are ample opportunities in the Central American sugarcane sector to foster discussion of diversification as part of the overall issue of competitiveness. The opportunity to assist the development of sugar cogeneration, as well as concerns over the environmental impact of sugar processing, should provide an opportunity for the Central American Sugarcane Initiative to foster discussion on several key diversification issues and their impact on the sustainability of sugar production in this region.

## VI. Issues Affecting New Product Integration in the Sugarcane Sector: The Case of Electricity

The recognition of cogeneration and surplus electricity as a new and profitable product for the industry must be contextualized within the general discussion on how this sector can be helped to move more aggressively into a new market niche.

In specific relation to power cogeneration in Central America, some of the following points are important in the overall discussion:

1. **Efficient Use of Bagasse**: It is important to address the diversity of steam and energy balances in sugar mills, with energy conservation as a key element, to obtain excess bagasse for other uses. It is also crucial to consider a wide range of steam conservation options i.e.: bagasse pre-dryers, pre-evaporators, use of continuous vacuum for low grade sugar extraction, installation of air preheaters and savers, closing pressure reducing valves to force additional steam to the turbogenerators, etc. Most of the discussion is aimed at reducing bagasse consumption (by 10-20%), allowing the sugar mill to export power or sell bagasse for other uses. The main obstacle in this respect is the reluctance of most plant managers to introduce changes in their existing and normally very old facilities. This situation can be corrected with appropriate training and sharing of experiences at the plant level. Another concern in this area relates to the general trend in the "survival" rate of the smaller mills, and also to the additional capacity provided by projected new and more efficient mills.

2. **Risks**: Consider carefully the generation/export options that are available to each mill in the context of the emerging power markets and determine the market goal for power (either peak electric supply, firm power to the grid, supplementary thermal oil generation, season exchanges).

   Careful definition of market conditions and the evaluation of different options are essential to define appropriate levels of investment by a mill. Investment in a sugar cogeneration project accomplishes two main objectives: it enhances the power side and to the mill processing side. There needs to be a balance of the two sides in order for the investment to be attractive. Based on this, the mills decide upon the technology and cost structures that they can manage, therefore managing risks on the investment (which has normally being taken by the existing plant, and not by a newly formed power company within the mill organization).

   Perceptions concerning technology risk are also important from the point of view of selecting the most appropriate combination of operational parameters. Most plant managers are concerned about the management and engineering impacts that more efficient technologies may have on their facilities. Efficient cogeneration projects will require changes in the management practices of most mills in the region, since the introduction of technology is likely to have a major effect on the normal tasks of a plant manager. The BUN-CA Initiative has many opportunities to promote better understanding of the "technology management" issue, which is causing the sector to be wary of the risks of sugar cogeneration.

3. **Fuel Price**: It is important to address the issue of fuel prices and determine what the fuel is worth to the power plant, and not just to the sugar mill. This is important when investment portfolios are considering not only power from bagasse but also

some other potential uses, such as material for board production. For example, the Guatemalan Sugar Cane Producers Association, together with the sugar mills participating in the cogeneration program, are interested in determining the real cost of bagasse to their power plants. This price affects their decisions in terms of using bagasse from other mills, using other biomass fuels (from rubber plantations) vs. thermal fuels during off season operation.

4. **Available Financing Mechanisms:** Financial mechanisms are key to supporting sugar cane cogeneration. The region's traditional financing mechanisms, which are based on guarantees, are hardly attractive to sugar mill owners because most of them already have congested investment portfolios (loans for agricultural production and for mill operations). Introducing the possibility to export power also poses the challenge of how to effectively finance a new type of business venture. The region's banking and financial institutions can be assisted in developing new approaches to finance sugar cane cogeneration projects. This key issue must be considered to reduce the financial closure time of sugar cogeneration projects (potential short term implementation is a major competitive advantage of sugar cogeneration).

   Most of the deals financed in Central America have been done using traditional corporate banking methods or have been financed by internal cash flows from the sugar mill. Although this has been successful in some projects, it is clear that in order to have more replicable projects, especially in smaller mills with power export potentials in the 1 to 5 MW range, new financial mechanisms need to be in place in the region's financial community.

   The financing of private projects in the region is becoming highly competitive and financial intermediaries are becoming very selective about the projects they fund. This is forcing project developers to focus more on competitiveness.

5. **Power Sales Contracting:** This issue is key to cogenerated power. Normally the buyer -- the utility -- wants to control delivery, and therefore defines as a customer the total number of hours of power exchange. Many mill owners for whom sugar is the main activity, perceive this as a major risk, preferring the low-risk investments involved in informal power exchanges (the utility buys whatever the mill has to offer at a certain point in time).

   The delivery issue places most of the risk on the generator's side, and imposes additional staffing and equipment maintenance costs in return for higher yields. This point also relates to the aforementioned technology management of sugarcane cogeneration projects.

   Guatemalan sugar mills for instance, through the existing cogeneration program, retain a certain degree of control on delivery since the utility has to buy their power, which they supplement using thermal generation. By contrast, in Costa Rica, the

local utility maintains total control over delivery and prefers not to sign "take or pay" contracts.

Most of these power purchase issues can be resolved with appropriate contracts, and this a major issue to be addressed in the region, especially with the emergence of new pool systems and the development of wholesale electricity markets in some countries.

This is an area of major concern to be addressed by the sugar sector, if it wishes to take a more active role in the emerging electricity markets in Central America.

Power prices are very much an issue and apart from Costa Rica, where an independent power producers' tariff has been agreed, this matter is still under discussion in most of the other countries. In Guatemala, recent decrees have established criteria for calculating tariffs, but other countries are still well behind in deciding which figures and procedures should be used to estimate tariffs. Central American project developers have expressed their frustration at the fact that these negotiations are often conducted on a one-to-one basis with local utilities.

Both the national sugar associations and the Azucareros del Istmo Centroamericano, AICA, should work together to retrieve the experiences of each specific project, and bring it into the open light of the sector's political discussions.

Finally, the larger issue of developing sugarcane cogeneration depends on the realization that electricity is a new and very profitable product for the sugar industry. Opening the eyes of the sugarcane sector to this notion requires major leadership and transformations, to enable many sugar mills, not just a few selected ones, to participate in the emerging energy markets in Central America.

## VII. Conclusions

This study has presented a "bird's eye" view of the sugar sector in Central America, from the perspective of its potential for sugarcane power cogeneration. A number of issues clearly stand out:

The market potential for sugar cane cogenerated power is relatively high in the short term with a potential development of up to 250 MW of installed capacity. In the longer term, the figure could be much higher. At the same time, the identified market opportunities for this power must be consolidated, otherwise other technologies will become strong competitors in providing the required capacity expansions in most countries in the region.

The traditional markets for power have been the local utilities, and the sugar mill industry has not looked at other potential niches, such as emerging municipal customers, mini-micro utility developments, and the joint venture operation of "power centers", which

can receive excess bagasse. Projects developed to date show that only the larger mills with the possibility of using supplementary fuels (for off-season generation) have proven competitive in negotiating power contracts.

The use of technological improvements in both the processing and power sides of the emerging business has been incremental, with boiler expansions tending to move from lower to medium pressures, rather than using higher and more efficient operating pressures. This is possibly due to the risks perceived by mill owners and a combination of operating criteria and capabilities needed to support more efficient technologies. In general, the technology used has been mainly second-hand and very cost-effective for the country and in terms of the risk perceptions under which the industry operates. Moreover, few mills in the region have consistent programs aimed at improving plant competitiveness. It is not clear what the sector's perception of the construction of newer and more efficient mills is, and this issue could sharply affect its future power contributions.

The investment levels and more importantly, the financial instruments used to finance projects, are still very traditional from the point of view of corporate-guarantee based financing. This makes it very difficult for many sugar mills to enter the highly competitive emergent private power business in the region. Although the larger mills in Central America have projects under way, most of the small to medium size mills (up to the range of 3,000 TCD) have faced many technical and financial problems in their pre-investment activities. It should be noted that it is the perception that sugar mill investment portfolios are heavily loaded, making the sector reluctant to risk new ventures such as investments in power exports.

Power contracts signed between sugar mills and utilities do not properly reflect the issues faced by a cogeneration developer, since most of the risk is assumed by the sugar mill. If cogeneration is to develop more widely in the region, there must be more discussion on how to structure better power deals, learning from experiences in other latitudes that show it is possible to reach acceptable levels of risk-sharing in project development and operation for the parties involved.

There is a general lack of integrated discussion in the sector on the issue of electricity as a new and key product for the industry. If cogeneration and power exports are to become expressions of a renovated and more competitive sector, the sector's key associations and organizations need to be more actively involved in discussions and policy-making on these issues. There has been ample training and site evaluations to determine the potential of sugarcane cogeneration. What has been lacking to date, however, is concerted sectoral commitment to this alternative. This is partly due to the fact that the sector's efforts have focused on issues such as international market participation, internal transformations (e.g. privatization processes, access and consolidation of production lands, etc.). It is now time to promote sugar cogeneration, using the opportunity to expand the sector's vision and incorporate diversification and environmental sustainability issues at the forefront of the discussion on competitiveness.

The overall potential for sugarcane cogeneration in Central America is an important angle from which to consider the competitive aspects of this traditional agricultural sector -- not only from the perspective of creating a new product for the sector, but also based on the critical need for the region's countries to expand and consolidate their energy infrastructure and become more competitive. Sugarcane cogeneration merits the development of adequate policies and perspectives that can contribute to the overall competitiveness of the Central American region.

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