Slide One, [UPGRADING SUGAR FACTORY OPERATIONS FOR IMPROVED ENERGY UTILIZATION] Presented To The Symposium [FUELS AND FEEDSTOCKS FROM TROPICAL BIOMASS] at Caribe Hilton Hotel, San Juan, Puerto Rico on November 24 and 25, 1980 by the CENTER FOR ENERGY AND ENVIRONMENT RESEARCH, UNIVERSITY OF PUERTO RICO & U.S. DEPARTMENT OF ENERGY 106.

CHER - 3-106: UPGRADING SUGAR FACTORY OPERATIONS FOR IMPROVED ENERGY UTILIZATION presented at the Symposium FUELS AND FEEDSTOCKS FROM TROPICAL BIOMASS at Caribe Hilton Hotel, San Juan, Puerto Rico on November 24 and 25, 1980 by Héctor M. Rodriguez - PE EER - UPR.

UPGRADING SUGAR FACTORY OPERATIONS FOR IMPROVED ENERGY UTILIZATION by Hector M. Rodriguez - PE. Until recently, sugar mill operators considered bagasse a necessary evil. It had to be used as inefficiently as possible to avoid spending money on disposal of any excess over and above boiler firing capacity. Small amounts were stored for use during mill shutdowns, but any excess was typically incinerated in some open space outside the factory grounds. With the escalating price of energy following OPEC oil price rises, mill operators have recognized the need to upgrade operations so that any excess energy over that required for sugar processing is not wasted. Changes in field operations have forced some sugar factories to supplement bagasse with expensive fuel oil to generate the power and steam required for milling cane and processing the juice into sugar and molasses. It is no longer possible to operate inefficiently, and some sugar producing regions have taken steps to maximize energy efficiency and conservation in their sugar cane industry practices. In Puerto Rico, most sugar mill boilers operate at very low pressures, ranging from 125 to 175 psig, thereby severely curtailing their ability to transform the heat values in bagasse into usable power. While it is not possible to attain utility boiler pressures with such a

Low-grade fuel, such as bagasse, is used in boilers elsewhere.

These are operated at much higher pressures without the need for any auxiliary fuels. This has been achieved by using bagasse dryers that utilize waste heat from the plant boiler. In doing so, they have facilitated higher furnace temperatures, reduced excess air requirements, increased boiler efficiency, and lowered particulate emissions.

To illustrate how these factors impact the thermal balance of a sugar mill, we examined a sugar mill that processes 7,500 tons of cane every 24 hours. These conditions are fairly typical for Puerto Rico. We calculated how much surplus electrical energy could be generated under optimal current operating conditions, both with and without the addition of a bagasse dryer and a high-pressure boiler.

The dryer would decrease the moisture content of the bagasse to 40%, and the boiler would operate at 640 psig and 640°F. A steam turbo-generator would utilize the excess steam under various schemes. We considered the following options:

1. Operate under current conditions, both with and without a bagasse dryer. Steam not needed for operations could be used by a neighboring industrial operation or expanded to 4" Hg. Abs. with

suitable condensing equipment (see Tables 1A and 1B; Figs. 1A and 1B).

2. Add a high-pressure boiler and use all produced bagasse as fuel. Excess low-pressure steam could be provided to another industrial operation or expanded to 4" Hg. Abs. under appropriate conditions (see Table IIA and Fig. TIA).

3. Same as 2, but only burn the quantity of bagasse required to generate 300,000 lbs of steam per hour needed for sugar operations. The rest could be stored for off-season operation or sold for fuel and/or fiber use (see Table II and Fig. TIB).

Table TIT shows that drying the bagasse to 40% moisture content does not significantly increase electric power generation if it is used to produce steam at the low pressures currently prevalent in the sugar industry in Puerto Rico.

The corrected text:

Thus, the available power increases only by 18% under optimum conditions. However, if a relatively high-pressure boiler is fired with this 40% wet bagasse, it is possible to increase electrical power generation up to 128% over the former case. In Case ITB, less than half of all the raw bagasse produced by the sugar mill is needed to generate all the steam required for factory operations. This steam is capable of generating about 8500 KW, of which 2500 are consumed in house, the balance of 6000 KW are available for sale. The excess steam may be stored and used to run the steam and power system during the off-season; producing at least 16,000 KW for sale if enough generating and condensing capacity is made available.

CALCULATIONS

General Information:
Capacity - 7,500 tons cane/24 hrs
Filter = 188 cane ° raw
Bagasse Analysis
Fiber 42%
Brix 5
Ash 18%
Moisture 52%

Total Fiber = 7,500 x 0.18 = 1,350 tons/day
Brix 161 "/day
Ash 2"
Total Dry Weight = 1,583 tons/day
Total Raw Bagasse = 3,214.6 tons/day

Flow Per Hour (Raw) = 133.9 tons
Flow Per Hour (40% wet) = 107.2 tons

HHV AOE bagasse = 4,907 BTU/lb

HHV 52% bagasse = 3,958 BTU/lb

Boiler Efficiency (40%) = 683 BTU/lb
Boiler Efficiency (52%) = 62%

Steam Rate 625 psig to 140 psig = 34.95 lbs/steam
Steam Rate 140 psig to 15 psig = 37.15 lbs/steam
Steam Rate 140 psig to 4 psig = 19.84 lbs/steam

Case I: OPTIMUM CAPACITY WITH LOW PRESSURE BOILERS

Weight Raw (52%) bagasse
Total heat In bagasse
Total heat to steam
Steam flow
Steam for process
Balance for power
Surplus power to 15 psig

Using bagasse dryer
Weight 40% W bagasse =
Total heat in bagasse =
Total heat to steam =
Steam flow -
Steam for process =
Balance for power -
Surplus power to 15 psig =

Case 1A: HIGH PRESSURE BOILER

Weight 40% W bagasse

= 107.2 Tons of Heat in bagasse = 1,060 x 108 BTU/hr Heat to steam. Steam flow = 603.8 M lbs/hr. Surplus Power to 140 psi = 17,276 KWe “A”. Surplus power to 15 psig = 8,178 KWe "B". Surplus power to 4" Hg. abs = 15,313 KWe. In Case 118 - 300,000 lbs/hr pressure boiler, steam flow is 300,000 lbs/hr. Surplus power to 140 psig = 8,584 KWe. Bagasse required = 53.3 tons/hr. Surplus bagasse (402m) = 53.9 tons/hr. Equivalent raw (52%w) bagasse to storage = 67.4 tons/hr, 1,617.6 tons/day.

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TABLE II - AVAILABLE POWER 1A IBA 1A 1-18. Bapate votature £ 2 oo “© sean Prensure Fate wo Mo oo we steam mbes fast eo to Procens albe/ae | 2000 200 rorower meme | ask atk tk =a Tower to 15 psig, mie | 9,468 AL,sue 6962544541410 Power to 4"liga, KWe ! 17,692 20,867 $3175 32, #11,722