# MONOGRAPH SERIES

## Center for Energy and Mineral Resources

Energy Generation from Cotton Gin Trash: An Economic Analysis

Ronald D. Lacewell
C. Robert Taylor
Edward A. Hiler

January, 1981

ACKNOWLEDGMENT

The authors would like to acknowledge the financial and material support of the following organizations: the Texas Agricultural Experiment Station, the Center for Energy and Mineral Resources, the Office of Technology Assessment, and the Texas Energy and Natural Resources Advisory Council. Neither the Texas Energy and Natural Resources Advisory Council nor any of its employees, contractors, subcontractors, or their employees, make any warranty, expressed or implied, or assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represent that its use would not infringe privately owned rights. The report is a product of the efforts of those conducting the project and does not necessarily represent the views of members of the Texas Energy and Natural Resources Advisory Council.

# ENERGY GENERATION FROM COTTON GIN TRASH: AN ECONOMIC ANALYSIS

Ronald D. Lacewell, Department of Agricultural Economics

C. Robert Taylor, Department of Agricultural Economics

Edward A. Hiler, Department of Agricultural Engineering

January, 1981

# INTRODUCTION

Texas harvests and processes more cotton than any other state with the crop often exceeding 5 million bales. Approximately 90 percent of the crop is harvested by mechanical strippers which collect the lint, seed, burr and bits of stalk. So, a relatively large volume of foreign matter (700 to 1200 pounds per bale) is carried to the gin.

The foreign matter, referred to as gin trash, is separated and cleaned from the cotton lint and seed during the ginning process. Accumulated gin trash is periodically removed at a cost between $4 and $8 per ton of trash or $2 and $4 per bale of cotton. In the past, gin trash has been spread on cropland. However, the spread of weed seed and disease makes this practice undesirable to many farmers.

Cotton producers and gin operators have been trying to identify a beneficial use of gin trash. An idea currently being discussed is using gin trash to power the gin itself. This use would provide a centralized, readily available energy source and a solution to the disposal problem. In addition, gin trash is one agriculturally derived fuel that does not directly impact soil conservation because it has already been removed from the land.

# METHODS AND MATERIALS

This study consists of economic analyses of electric power generation and low-Btu (British thermal unit) gas generation from cotton gin trash. Both analyses consider the use of a very large "super gin," sized at 40,000 bales per year. The gin would generate 15,000 tons of gin trash available in 1,500 modules weighing 20,000 pounds each. All gin trash is assumed to come from the case study gin.

A fluidized-bed combustor would be used to produce the low-Btu gas and in conjunction with a boiler and turbine to produce electricity. The combustor consists of a chamber of sand-like particles supported by a porous floor. Air under pressure is forced through the porous floor and up through the particles. The velocity of the air can be controlled so that the particles in the chamber are lifted and suspended in a churning turbulent mass, which is called a fluidized bed. The bed material looks and behaves like a boiling liquid. Heavy objects will sink while light objects will float.

In a fluidized-bed unit, the sand-like particles absorb and store heat, while the turbulence of the churning bed keeps the temperature uniform throughout the bed. When fuel is introduced into the fluidized bed, it rapidly absorbs heat from the solid particles until it ignites and burns. This action permits a wide range of low-grade fuels of non-uniform size and varying moisture content to burn efficiently.

The gin trash, used as fuel, would be consumed at a rate of 25.6 million Btu per hour or 3,666 pounds per hour, based on 341 days of operation per year. Characteristics of gin trash use for on-site energy production are shown in Table I.

TABLE I: CHARACTERISTICS OF GIN TRASH USE FOR ON-SITE ENERGY PRODUCTION

| Characteristic | Value |
|---|---|
| Gin size | 40,000 bales/yr |
| Period of operation | 341 days/yr |
| Gin energy use | |
| Electricity[a] | 60 kw/bale |
| Natural gas[a] | 300,000 Btu/bale |
| Gin trash produced[b] | 15,000 ton/yr |
| Energy potential, gin trash | 25.6 million Btu/hr |
| Rate of use, gin trash | 3,666 lbs/hr |
| Equipment costs | |
| Fluidized-bed combustor[c] | $520,000 |
| Boiler and turbine[c] | $348,400 |

[a]Personal communication with Calvin Parnell, Texas A&M University. Typically, 60 kw of electricity are used in ginning and 300,000 Btu in drying each bale of cotton.

[b]This would be 1,500 modules, each weighing 20,000 pounds. No storage cost is included in the analysis as the gin yard is available for storage. Risk costs for fire and deterioration are also not included.

[c]Personal communication with Dr. Bill Holm, Texas A&M University. Based on bids received by Texas A&M in 1978.

# RESULTS

## Electricity Production

A fluidized-bed combustor in conjunction with a boiler and a turbine would be used to generate electricity. Heat produced in the fluidized-bed would be used to heat the boiler. The investment in equipment would be $868,400. Electricity produced would be 7,775 Mwh (megawatt-hours) per year. Gin operation requires 2,400 Mwh per year for ginning and 12 billion Btu of natural gas for drying cotton. These and other characteristics related to the economics of on-site electrical generation are listed in Table II.

The estimated annual cost for the on-site generation of 7,775 Mwh is $300,000 or 3.87 cents per kwh (kilowatt-hour), which was competitive with local rates in 1979. Table III summarizes the economic implications of on-site electrical production.

Economic feasibility is not based directly on local rates. For this case study, the consideration of economic feasibility also involves the saving of the cost of energy not purchased, the sale of surplus electricity, and the saving of the cost of gin trash disposal eliminated; all are results of on-site energy generation. Electricity requirements will be satisfied, and waste heat will be used for cotton drying. The savings that would result from these two measures total about $126,000 (based on a 300,000 Btu per bale requirement for cotton drying with natural gas priced at $2.50 per thousand cubic feet and electricity priced at 4 cents per kwh).

A surplus of 5,375 Mwh of electricity generated at the gin would be sold to the distributor for 2 cents per kwh, which is a basic credit currently practical in the region and which amounts to the cost of fuel for electrical generation by the power company. Sales of surplus electricity would yield an income of $107,500.

The total credit for electrical generation is an estimated $233,500 and the total cost of electrical generation is $300,000, which leaves $66,500 in expenses not covered. However, this is only $1.66 per bale from being economically feasible. Gins currently incur a cost of $2 per bale to dispose of gin trash. When this cost is eliminated by using gin trash in the electrical generation process, the facility appears to be economically feasible.

TABLE II: CHARACTERISTICS OF ON-SITE ELECTRICAL PRODUCTION[a]

| Characteristic | Value |
|---|---|
| Energy input | 25.6 million Btu/hr |
| Energy output | 950 kw/hr |
| Investment | $868,400 |
| Annual fixed costs | $153,700 |
| Cost to module trash[b] | $15,000/yr |
| Variable costs of operation[c] | $132,000/yr |
| Total energy produced | 7,775 Mwh |
| Cost per unit | 3.87 cents/kwh |
| Electricity replaced | 2,400 Mwh |
| Natural gas replaced[d] | 12 billion Btu |
| Surplus electricity sold[e] | 5,375 Mwh |

[a]Based on a 40,000-bale per year gin, using trash from this gin only. Other characteristics are outlined in Table I. Based on 25.6 million Btu/hr of gin trash being burned in a fluidized bed with 17 percent efficiency in the electricity generation process.

[b]Based on $10 per module of 20,000 pounds each.

[c]Estimate based on Beck and Parker. Cost of operation of the boiler and turbine are not well established.

[d]It is assumed that waste heat is used for drying cotton.

[e]It is assumed that electricity is placed into a system for a credit of 2 cents per kwh. No provisions for distribution are included.

TABLE III: ECONOMIC IMPLICATIONS OF ON-SITE ELECTRICAL PRODUCTION

| Characteristics | Value |
|---|---|
| Energy produced | 7,775 Mwh |
| Surplus energy produced | 5,375 Mwh |
| Cost of generation | $300,000/yr or 3.87 cents/kwh[a] |
| Typical gin electricity costs | $2.40/bale |
| Typical gin energy costs[b] | $96,000/yr |
| Credits from generation | |
| Electricity not purchased[c] | $96,000/yr |
| Drying energy not purchased[d] | $30,000/yr |
| Electricity sold[e] | $107,500/yr |
| TOTAL | $233,500/yr |
| Net cost of electrical generation | $66,500/yr |

[a]Does not include storage cost for the 1,500 modules of gin trash. Air quality standards are also not considered.

[b]Given a 40,000 bale per year gin which is much larger than average.

[c]Based on 2.4 million Btu at 4 cents per kwh.

[d]Based on 12 billion Btu at $2.50 per one million Btu.

[e]Based on 5,375 Mwh sold at 2 cents per kwh.

[f]Not including a credit for gin trash disposal which is estimated to be $2 per bale or $80,000 for a gin of this size.

Low-Btu Gas Production

A fluidized-bed combustor would be used to produce a low-Btu gas. The process would be similar to the one previously described, except that the level of oxygen would be greatly reduced. For gasification, the fluidized bed would be used with a 61 percent efficiency of energy input to energy output available as a gas (Beck and Parker, 1979). The basic assumptions made for the electricity production process apply to the low-Btu gas production process, except that there would be no boiler or turbine. Table IV presents an overview of gas production characteristics.

The cost of the fluidized-bed would be $520,000, and the cost of gas production would be an estimated $239,040. Total gas production for one year would be 127.7 billion Btu. Thus, the cost per million Btu would be an estimated $1.87, which is very competitive with the current market price of natural gas. However, this cost estimate is limited in that it does not consider gas cleanup or distribution.

TABLE IV: ECONOMIC IMPLICATIONS OF ON-SITE GAS PRODUCTION[a]

| Characteristics | Value |
|---|---|
| Gas production | 15.6 million Btu/hr or 127.7 billion Btu/yr |
| Investment | $520,000 |
| Fixed costs | $92,040/yr |
| Cost to module trash[b] | $15,000/yr |
| Variable cost of production[c] | $132,000/yr |
| Total cost of production | $239,040/yr |
| Total cost of production[d] | $1.87/million Btu |

[a]Based on 40,000 bales per year using gin trash from this gin only. Other characteristics are outlined in Table I. Based on 25.6 million Btu per hour being burned in a fluidized bed with 61 percent efficiency (Beck and Parker, 1979) in gas production.

[b]Based on $10 per module of 20,000 pounds each.

[c]Estimate based on Beck and Parker and scaled down.

[d]Does not include a storage charge for the 1500 modules of gin trash, gas cleanup costs, or distribution costs.

## CONCLUSION

Because the economic implications of these analyses are favorable, limitations must be emphasized. Costs of gin trash storage, maintenance, and loss were not considered in either analysis. For electricity production, boiler and turbine operating cost estimates were obtained from a variety of sources, and in some cases, the estimates were scaled up or down to fit a particular system.

An energy producing facility must operate several months of the yeat to compete economically, which means that energy (gas or electricity) will sometimes be produced when it is not needed. It was assumed that both gas and eletricity could be sold on the wholesale market without difficulty or cost. However, in the case of electricity the usual credit for surplus is substantially less than the market price (i.e., 2 cents per kwh as opposed to 4 cents per kwh).

The analyses emphasize the serious need for the demonstration and testing of the energy production processes and facilities. The systems need to be operated and monitored to refine the estimates of labor, investment, and operating costs.

# REFERENCES


Beck, Stephen R. and Harry W. Parker, Assessment on Energy and Biological Processes, Task V, Part I: Engineering Aspects of Thermochemized Conversion. Lubbock: Texas Tech University Department of Chemical Engineering, 1979.

Holm, Bill, Personal communication. College Station: Texas A&M University Department of Mechanical Engineering, 1978.

Parnell, Calvin, Personal communication. College Station: Texas A&M University Department of Agricultural Engineering, 1978.