Energy Division


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Presented at

Rural Energy and Economic Development
Knoxville, TN
November 9-10, 1994

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Prepared by the
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6205
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contact DE-AC05-84OR21400

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BIOENERGY: WHAT'S IN IT FOR THE GROWER —

THE COST OF PRODUCING DEDICATED ENERGY CROPS:
COMPARISONS WITH CONVENTIONAL CROPS

Marie Walsh, Oak Ridge National Laboratory
The Cost of Producing Dedicated Energy Crops: Comparisons with Conventional Crops

Biomass has the potential to become a significant source of energy feedstocks in the United States in the next century. The change from fossil fuels to biomass energy systems can offer many environmental benefits such as improved air, water, and soil quality. But for this to become a reality several economic criteria must be met. The feedstock price and cost of converting cellulosic materials to electricity and ethanol must be competitive with conventional energy sources to be attractive to electricity and ethanol facilities. But this is only half of the picture. For biomass energy systems to be commercially successful, the price offered by power, ethanol, and chemical companies must be high enough such that farmers producing biomass can earn a profit at least equal to the profit that could be earned from producing conventional crops. Significant displacement of conventional fuel sources with biomass will require production of dedicated energy crops on millions of acres of land. Farmers will be asked to convert agricultural cropland from the production of conventional crops such as corn, soybeans, and wheat to the production of dedicated energy crops. Simply being profitable will not be sufficient to stimulate large scale production. Dedicated energy crops must be at least as profitable as conventional crops that could be grown on a given site before farmers will produce energy crops on that site. This presentation will concentrate on the cost of producing dedicated energy crops and compare those costs to the profitability of conventional crops. This comparison allows one to estimate a breakeven price, that is, a price for which the profitability of dedicated energy crops is equivalent to the profitability of conventional crops.

The Biofuels Feedstock Development Program has attempted to estimate the cost of producing dedicated energy crops for several regions of the United States. Switchgrass and hybrid poplar have been chosen as representative herbaceous and woody crop species for the estimation. Table 1 summarizes the basic assumptions and approach used in the estimations. A full economic cost accounting approach is used. This means that not only are out-of-pocket cash expenses (e.g., fertilizers, chemicals, seeds, fuel, repairs) estimated, but fixed costs (e.g., overhead, taxes) and the costs of owned resources (e.g., producer's own labor, equipment depreciation, land values) are also estimated as part of the cost of producing dedicated energy crops. The costs are estimated as enterprise budgets which means that costs of producing energy crops are estimated as separate
entities, and not estimated in context of the entire farm management structure. The approach taken is to use engineering specifications to estimate equipment costs per hour and to estimate the number of hours per acre required to complete each production operation. These two pieces of information can be used to estimate per acre production costs.

Farmers are assumed to own all of the equipment needed to produce energy crops except the equipment needed to harvest poplars. Machinery and equipment complements typical of commercial-scale farm operations in the region are used to make the estimates. Equipment size tends to vary by region. All input prices are in 1993 dollars. Costs are estimated for on farm production only. Transportation costs from the production site to the utilization site are not included. The approach and methodology used are, to the greatest extent possible, consistent with that used by the US Department of Agriculture--Economic Research Service to estimate the costs of producing major field crops. Thus the production cost estimates are consistent with production cost estimates of major field crops and are readily comparable.

The production scenarios (table 2) estimated assume that site preparation includes moldboard plowing and disking. Lime, phosphorous, and potassium are broadcast applied as needed prior to planting. Quantities used for estimation are those typically used in the region for the production of other crops. Herbicides to control competing grasses and broadleafs are applied to aid establishment. Weed control is assumed to be necessary only in the establishment year for switchgrass, but is needed until canopy closure (typically year two) for hybrid poplars and consists of both chemical and mechanical weed control. The analysis assumes annual applications of nitrogen for switchgrass and biannual nitrogen applications for hybrid poplar. Hybrid poplars are assumed to be planted at a 6’ x 8’ spacing (910 trees/acre). Switchgrass harvest is assumed to consist of mowing, raking, and round baling and it is assumed that farmers own the harvesting equipment. It is assumed that hybrid poplar harvest is by custom operation, and given the lack of data available for custom harvest rates for short rotation, intensely managed trees, it was necessary to estimate what these costs might be. Rotation lengths for switchgrass are assumed to be 10 years and are 7 years for hybrid poplar.

It is recognized that the assumed machinery complement and management scenarios used in estimation will not be employed by all farmers in all situations. Some farmers will be able to produce dedicated energy crops at costs lower than those estimated, while for other farmers, it will cost more. Additionally, in some
regions, energy crops other than hybrid poplar and switchgrass might be produced resulting in potentially different production costs. The approach taken was to estimate production costs that could be reasonably achieved throughout a region under the assumption of commercial scale production. Thus the estimated costs employ somewhat conservative assumptions.

Production costs are estimated for six regions of the United States—the Lake States (MI, MN, WI); the Corn Belt (IA, IL, IN, MO, OH); the Southeast (AL, GA, SC); Appalachia (KY, NC, TN, VA, WV); the North Plains (KS, NE, ND, SD); and the South Plains (OK, TX). It is assumed that switchgrass can be grown in all six regions, but hybrid poplar will not be grown in the South Plains. The regions chosen are not all inclusive—production can occur in other states as well. Regions chosen correspond to the production regions used by USDA to estimation the costs of producing conventional crops.

Production costs vary by region with land rents being a major contributor to the differences (Tables 3 and 4). Differences in labor costs, machinery complement, switchgrass variety planted, and fertilizer inputs used also contribute to regional differences in production costs. Also, fixed costs vary substantially by region. For hybrid poplars, harvesting costs constitute the largest percentage of total costs (65 percent), followed by establishment costs. The skidding operation is the most expensive component of poplar harvesting, representing nearly half of the harvesting costs. Poplar harvesting costs vary by yield; for mean annual increments of 3 dry tons/acre/year, per acre costs are $604 and per ton costs are $29. Per ton costs decrease to $19 ($670/acre) for yields of 5 dry tons/acre/year and to $15 ($720/acre) for yields of 7 dry tons/acre/yield.

Competitiveness of energy crops with conventional crops vary by region. Profitability of conventional crops is based only on market revenue—farm commodity payments are not included. Breakeven prices for biomass crops are lower in the Southeast/Appalachia regions and the Plains regions than for the Lake States/Corn Belt. Biomass production costs and profitability of conventional crops are highest in the Lake States/Corn Belt which explains the higher breakeven prices. Breakeven prices for poplar are higher than for switchgrass in all regions, in large part due to the higher cost of producing poplars. The breakeven prices are regional averages. It should be recognized that areas exist within each region where the breakeven price might be substantially lower than those reported. Likewise areas of higher breakeven prices likely exist.
Table 1: Basic Assumptions and Approach Used to Estimate the Cost of Producing Dedicated Energy Crops

- A full economic cost accounting approach is used.
- Estimated production costs are enterprise budgets.
- Costs are estimated using a machinery complement typical of commercial-scale farm operations in the region.
- It is assumed that the farmer owns the equipment needed to produce energy crops except where noted.
- All input prices are in 1993 dollars
- Costs are calculated for on-farm production only. Transportation costs are not included.
Table 2: Management Scenarios Assumed in Estimating the Cost of Producing Dedicated Energy Crops

- Site preparation consists of moldboard plowing and disking.
- Lime, phosphorous, and potassium applied as needed.
- Herbicides are used to control competing grasses and broadleaves during establishment year for switchgrass.
- Herbicides and mechanical cultivation used to control competing grasses and broadleaves until canopy closure for hybrid poplar.
- Nitrogen is applied annually to switchgrass and biannually to hybrid poplar.
- Hybrid poplars are planted at a 6' x 8' spacing (910 trees/acre).
- Switchgrass harvest consists of mowing, raking, and round baling.
- Hybrid poplars are harvested by custom harvest.
- Rotation length for switchgrass is 10 years.
- Rotation length for hybrid poplar is 7 years.
Figure 1: Production Regions for Dedicated Energy Crops

Lake States (MI, MN, WI)—Switchgrass and Hybrid Poplar
Corn Belt (IA, IL, IN, MO, OH)—Switchgrass and Hybrid Poplar
Southeast (AL, GA, SC)—Switchgrass and Hybrid Poplar
Appalachia (KY, NC, TN, VA, WV)—Switchgrass and Hybrid Poplar
North Plains (KS, NE, ND, SD)—Switchgrass and Hybrid Poplar
South Plains (OK, TX)—Switchgrass
Table 3: Cost of Producing Switchgrass by Region

<table>
<thead>
<tr>
<th></th>
<th>Lake States</th>
<th>Corn Belt</th>
<th>Southeast</th>
<th>Appalachia</th>
<th>North Plains</th>
<th>South Plains</th>
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<tr>
<td>Establishment</td>
<td>71.15</td>
<td>73.96</td>
<td>116.61</td>
<td>111.56</td>
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<td>40.45</td>
<td>46.61</td>
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<tr>
<td>Establishment</td>
<td>37.47</td>
<td>37.57</td>
<td>24.05</td>
<td>23.96</td>
<td>27.26</td>
<td>18.61</td>
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<tr>
<td>Establishment</td>
<td>20.85</td>
<td>18.24</td>
<td>24.06</td>
<td>23.44</td>
<td>20.70</td>
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<td>Maintenance and Harvest</td>
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<td>40.23</td>
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<td>Subtotal--Establishment</td>
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<td>164.72</td>
<td>158.96</td>
<td>102.71</td>
<td>127.70</td>
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<tr>
<td>Subtotal--Maintenance and Harvest</td>
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<td>116.97</td>
<td>113.05</td>
<td>90.85</td>
<td>61.34</td>
<td>101.03</td>
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<tr>
<td><strong>LAND</strong></td>
<td>54.00</td>
<td>86.00</td>
<td>28.00</td>
<td>42.00</td>
<td>36.00</td>
<td>23.00</td>
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Table 4: Cost of Producing Hybrid Poplar by Region

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<td>Establishment</td>
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<td>Maintenance (Yrs. 2-6 ave.)</td>
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<td>18.70</td>
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<tr>
<td>Establishment</td>
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<td>25.53</td>
<td>25.53</td>
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<tr>
<td>Establishment</td>
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<tr>
<td>Maintenance (Yrs. 2-6 ave.)</td>
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<td>6.11</td>
<td>6.25</td>
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<td>Subtotal--Establishment</td>
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<td>Subtotal--Maintenance</td>
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<tr>
<td>LAND</td>
<td>54.00</td>
<td>86.00</td>
<td>28.00</td>
<td>42.00</td>
<td>36.00</td>
</tr>
</tbody>
</table>

** Estimated cost of harvest is dependent on yield (specifically dbh of tree). Cost reported corresponds to a yield of about 3 dry ton/year/acre
Figure 2: Regional Costs of Producing Switchgrass

Regional Costs

- Establishment
- Maintenance and Harvest

$/Acre

Lake States | Corn Belt | South East | Appalachia | North Plains | South Plains

Costs vary across regions with the highest costs in Appalachia and the lowest in South Plains.
Costs of Producing Hybrid Poplar**

- Harvesting: 65%
- Establishment: 33%
- Maint.: 2%
- Other: 24%
- Chipping: 22%
- Felling: 8%
- Skidding: 46%

** Land Cost Not Included
Breakeven Prices of Biomass - Corn Belt & Lake States

Price ($/ dry ton)

Yield (dry ton)

Soybeans/Poplar
Corn/Poplar
Soybeans/Switchgrass
Corn/Switchgrass
Breakeven Prices of Biomass - Southeast/Appalachia

Price ($/dry ton)

Soybeans/Poplar
Corn/Poplar
Soybeans/Switchgrass
Corn/Switchgrass
Yield (dry ton)