Using Advanced Decision Analysis to Mitigate Project Risk for Large Scale Wood Pellet Export Projects

Presented by Dr. William Strauss
President, FutureMetrics
Founder and Director, Maine Energy Systems
November 29, 2012
Who is FutureMetrics?

We are Globally Respected Consultants in the BioEnergy Space

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Bethel, ME 04217, USA
www.FutureMetrics.com
FutureMetrics Services:

Research, analysis, and strategic guidance for the bioenergy sector.

We combine data driven analysis with a depth of knowledge across the bioenergy sector to provide full spectrum reporting that enables our clients to make optimal decisions.

Selection of Clients
FutureMetrics LLC

Pellet Export Project:
Prefeasibility and feasibility studies
Due diligence
Financial modeling
Risk analysis
Economic impact analysis
Expert advice
Dr. William Strauss
Recipient of the 2012 International Excellence in Bioenergy Award
<table>
<thead>
<tr>
<th></th>
<th>#2 Heating Oil</th>
<th>Wood Pellets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Fuel Consumption</td>
<td>1,300 gallons</td>
<td>10 tons</td>
</tr>
<tr>
<td>Annual Carbon Emissions</td>
<td>39,306 lbs</td>
<td>5,130 lbs</td>
</tr>
<tr>
<td>Fuel Cost (unit price)</td>
<td>$3.83 / gallon</td>
<td>$239 / ton</td>
</tr>
<tr>
<td>Annual Fuel Costs</td>
<td>$4,979</td>
<td>$2,408</td>
</tr>
<tr>
<td>Annual Savings*</td>
<td></td>
<td>$2,571</td>
</tr>
<tr>
<td>25 Year Savings*</td>
<td></td>
<td>$64,275</td>
</tr>
</tbody>
</table>
Centralized Heat with Wood Pellets
The MESys AutoPellet Boiler is ideal for central heating and domestic hot water. The fully-automated, highly efficient wood pellet boilers are designed to meet the demands of households, businesses and institutions without backup.
The homeowner never sees or touches the fuel. Bulk delivery and auto-feeding...

AutoPellet Boilers
- Automatic Operation
- Automatic Ash Removal
- Automatic Fuel Delivery
- No Fuel Handling
- Highly Efficient
- 40,000+ Units in Service
- Clean Burning

FINANCING AVAILABLE
- FHA guaranteed loans from Admirals Bank.
- Pellet fuel and boiler payment may be less than just your oil bill.

(207) 824-NRGY (6749) • MaineEnergySystems.com
Oil Production (billions of barrels per year)

Source: Various forecasts aggregated by FutureMetrics.
US Energy Policy?
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar energy</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>0.6%</td>
<td>0.6%</td>
<td>0.7%</td>
<td>0.8%</td>
<td>0.9%</td>
<td>1.2%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Biomass</td>
<td>60.7%</td>
<td>60.5%</td>
<td>60.1%</td>
<td>59.2%</td>
<td>62.3%</td>
<td>64.1%</td>
<td>63.8%</td>
<td>65.4%</td>
<td>66.0%</td>
<td>66.8%</td>
<td>66.6%</td>
<td>66.8%</td>
</tr>
<tr>
<td>Geothermal Energy</td>
<td>4.5%</td>
<td>4.7%</td>
<td>4.8%</td>
<td>4.5%</td>
<td>4.8%</td>
<td>5.0%</td>
<td>4.8%</td>
<td>4.6%</td>
<td>4.5%</td>
<td>4.3%</td>
<td>4.0%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Hydro power</td>
<td>31.3%</td>
<td>30.9%</td>
<td>30.8%</td>
<td>31.5%</td>
<td>27.2%</td>
<td>24.8%</td>
<td>24.5%</td>
<td>22.4%</td>
<td>21.4%</td>
<td>19.8%</td>
<td>19.6%</td>
<td>18.7%</td>
</tr>
<tr>
<td>Wind power</td>
<td>1.0%</td>
<td>1.3%</td>
<td>1.9%</td>
<td>2.3%</td>
<td>3.1%</td>
<td>3.6%</td>
<td>4.5%</td>
<td>5.2%</td>
<td>5.7%</td>
<td>6.7%</td>
<td>7.2%</td>
<td>7.6%</td>
</tr>
</tbody>
</table>

Georgia Biomass – 750,000 tons per year of pellets
Owned by RWE

RWE is one of Europe’s five leading electricity and gas companies and is the No. 1 power producer in Germany, No. 2 in the Netherlands and No. 3 in the UK.
FutureMetrics is the lead consultant on three large pellet export projects.
Lets look at a Hypothetical 250,000 ton per year export project

There are many areas of uncertainty.

We will look at:

- Wood price (which also includes diesel fuel price)
- Pellet selling price (which also includes price appreciation above inflation)
- Capital Cost
- Inflation
- And a few other items...
In this presentation we will not look at (except the “Tilbury effect” and at bit on optimal insurance):

- policy risk
- currency risk
- shipping cost risk
- market disruption risk (the “Tilbury effect”)

Torrefied pellet production;
- mass and energy balance sensitivities and cost of goods risk
- reliability and maintenance cost risk
- market demand risk (all of the above for export plus competition from white pellets)

Working capital issues;
- supply chain risk (catastrophic failure!)
- product lost risk (optimal insurance coverage)
Tilbury Fire – Feb. 27, 2012
What is THE number?

Wrong Question
Monte Carlo simulation is a computerized mathematical technique that allows people to account for risk in quantitative analysis and decision making.

The technique is used by professionals in a variety of fields such as finance, project management, energy, manufacturing, engineering, insurance, oil & gas, transportation, and the environment. (And now in Wood Pellet Project Analysis)

In Monte Carlo simulation, uncertain inputs in a model are represented using ranges of possible values known as probability distributions.

By using probability distributions, variables can have different probabilities of different outcomes occurring.

Probability distributions are a much more realistic way of describing uncertainty in variables of a risk analysis.

Monte Carlo simulation provides the decision-maker with a range of possible outcomes and the probabilities they will occur.
Wood Prices are about 55% to 65% of the Cost of Production of Pellets

source: Innovative Natural Resource Solutions, 2012
**Multiple Regression for BiomassPrice**

<table>
<thead>
<tr>
<th>Summary</th>
<th>Multiple R</th>
<th>R-Square</th>
<th>Adjusted R-Square</th>
<th>StErr of Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.9643</td>
<td>0.9300</td>
<td>0.9273</td>
<td>1.548191307</td>
</tr>
</tbody>
</table>

**ANOVA Table**

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean of Squares</th>
<th>F-Ratio</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explained</td>
<td>5</td>
<td>4200.762555</td>
<td>840.152511</td>
<td>350.5168</td>
</tr>
<tr>
<td>Unexplained</td>
<td>132</td>
<td>316.3903145</td>
<td>2.396896322</td>
<td></td>
</tr>
</tbody>
</table>

**Regression Table**

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-Value</th>
<th>p-Value</th>
<th>Confidence Interval 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-27.37722908</td>
<td>-5.8124</td>
<td>&lt; 0.0001</td>
<td>-36.69433328 -18.06012487</td>
</tr>
<tr>
<td>NEDiesel</td>
<td>2.507788569</td>
<td>7.2603</td>
<td>&lt; 0.0001</td>
<td>1.824534114 3.191043023</td>
</tr>
<tr>
<td>HousingStarts</td>
<td>-0.005467499</td>
<td>-11.6080</td>
<td>&lt; 0.0001</td>
<td>-0.006399209 -0.004535789</td>
</tr>
<tr>
<td>Precip</td>
<td>0.212217848</td>
<td>2.9024</td>
<td>0.0043</td>
<td>0.067581573 0.356854123</td>
</tr>
<tr>
<td>XXXX</td>
<td>0.353280366</td>
<td>12.1168</td>
<td>&lt; 0.0001</td>
<td>0.295606392 0.41095434</td>
</tr>
<tr>
<td>YYYYY</td>
<td>-0.015230028</td>
<td>-11.5684</td>
<td>&lt; 0.0001</td>
<td>-0.017834234 -0.012625823</td>
</tr>
</tbody>
</table>

**Scatterplot of Fit vs BiomassPrice**

![Scatterplot of Fit vs BiomassPrice](image-url)
NEDiesel: MA(2)
Transformations: Log, Difference (1)
Sync Data: 'Wood Prices'!$C$3:$C$140

X-axis is months – 10 year forecast
Housing Starts: MA(1)
Transformations: Difference (1)
Sync Data: 'Wood Prices'!$D$3:$D$140

- Mean
- 25% - 75%
- 5% - 95%
- Sample Path
- Historical
Precip: MA(1)
Transformations: Difference (1)
Sync Data: 'Wood Prices'!$E$3:$E$140
Another Key Variable for the Cash Flow Model is the Price of the Pellets
### US domestic price (industrial wood pellets) $/t

<table>
<thead>
<tr>
<th>Location</th>
<th>Delivery period</th>
<th>Bid</th>
<th>Ask</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland, Maine</td>
<td>spot</td>
<td>150.00</td>
<td>157.00</td>
<td>-1.50</td>
</tr>
<tr>
<td>Camden, New Jersey</td>
<td>spot</td>
<td>142.00</td>
<td>147.00</td>
<td>-0.50</td>
</tr>
<tr>
<td>Wilmington, North Carolina</td>
<td>spot</td>
<td>133.00</td>
<td>138.00</td>
<td>-1.00</td>
</tr>
<tr>
<td>Port Everglades, Florida</td>
<td>spot</td>
<td>132.00</td>
<td>138.00</td>
<td>-0.50</td>
</tr>
<tr>
<td>Mobile, Alabama</td>
<td>spot</td>
<td>125.00</td>
<td>132.00</td>
<td>-1.00</td>
</tr>
<tr>
<td>Chicago, Illinois</td>
<td>spot</td>
<td>114.00</td>
<td>124.00</td>
<td>0.0</td>
</tr>
<tr>
<td>Seattle-Tacoma, Washington</td>
<td>spot</td>
<td>125.00</td>
<td>132.00</td>
<td>-0.50</td>
</tr>
</tbody>
</table>

**FOB Spot Prices October 15, 2012 (from Argus Biomass Markets)**

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**Petroleum and Pellet Prices (per Barrel or Tonne)**

If Petroleum and Diesel Fuel increase at 8.50% per year, yielding a pellet price increase of 7.32% per year. Assumed 2.50% underlying inflation included.

**Diesel at 60% of wood cost**

**Wood cost at 55% of pellet cost**

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Analysis by FutureMetrics
Diesel Fuel and Wood Prices
The first metric we will look at is Return on Investment (ROI). This is the full capital cost including contingencies, working capital needs, etc, compared to the future net operating cash flows. The ROI is the internal rate of return (IRR) from these cash flows over 10 years. The mean of the simulated returns is 14.470%.

The project has a 15.3% probability of returning an ROI of less than 8%. But notice the long tail to the left!
Diesel is the primary forcing factor for wood prices. These are from the time series array that varies with each iteration of the Monte Carlo simulation,
ROI (Baseline) vs Sale Price of Pellets per Ton FOB (Baseline)

Output vs Key Input Scenarios

- X Mean: $17
- X Std Dev: $7
- Y Mean: 14
- Y Std Dev: 6.5
- Corr. (Pearson): 0.5
- Corr. (Rank): 0.5
The net equity cash out is the value of the accumulated excess cash flows in year ten net of the equity investment (40% of CAPEX).

In year ten the mean value is $100.7 million. There is a nearly a 0% chance it will be zero dollars or less.
4x EBITDA Multiple Year 3 (Baseline)

- Minimum: $27,171,014.59
- Maximum: $137,285,225.20
- Mean: $71,600,982.06
- Std Dev: $13,701,189.00
- Values: 5000

Values in Millions ($)
With 60% Debt / 40% Equity

4x EBITDA Multiple Year 3 (Baseline) vs Average Annual Inflation Rate (Baseline)

Output vs Key Input Scenarios
Cash at the end of Year 1 to cash at the end of Year 10

Baseline

Values in Millions ($)

- cash at the end of Year 1
- cash at the end of Year 2
- cash at the end of Year 3
- cash at the end of Year 4
- cash at the end of Year 5
- cash at the end of Year 6
- cash at the end of Year 7
- cash at the end of Year 8
- cash at the end of Year 9
- cash at the end of Year 10

- 95%
- 75%
- Mean
- 25%
- 5%
Let’s simulate the Tilbury Effect with a discrete probability distribution.

In this case, there is a 5% chance any given year that production will be 40% of the normal output. In those years, prices will be 80% of normal.
Two simulations: Blue line is with the potential for the “Tilbury” effect.

ROI (All Simulations)

Minimum: -27
Maximum: 39.
Mean: 14.
Std Dev: 6.5

ROI (Disruption)

Minimum: -91
Maximum: 39.
Mean: 11.
Std Dev: 13.

Mean = 13.46% 14.470%
Net Equity Cash Out Year 5 (All Simulations)

- **Net Equity Cash Out Year 5 (Baseline)**
  - Minimum: -$1
  - Maximum: $6
  - Mean: $16
  - Std Dev: $10
  - Values: 500

- **Net Equity Cash Out Year 5 (Disruption)**
  - Minimum: -$4
  - Maximum: $6
  - Mean: $13
  - Std Dev: $12
  - Values: 500

Mean = $16,728,171.18
Mean = $13,331,936.64
IRR on the Equity Investment - 5 Years (All Simulations)

Minimum: -39
Maximum: 57
Mean: 18
Std Dev: 11

Mean = 18.705%

Minimum: -86
Maximum: 57
Mean: 15
Std Dev: 14

Mean = 15.05%
What would the minimum to insure against the loss?

<table>
<thead>
<tr>
<th>Net Operating Cash Flows / Year</th>
<th>Min</th>
<th>Mean</th>
<th>Max</th>
<th>1 Percentile</th>
<th>Conditional Loss @ 1%</th>
<th>Max Loss @ 0.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>($8,883,319)</td>
<td>$2,514,061</td>
<td>$7,296,538</td>
<td>($4,205,495)</td>
<td>($42,055)</td>
<td>($44,417)</td>
</tr>
<tr>
<td>Year 2</td>
<td>($10,408,470)</td>
<td>$6,039,077</td>
<td>$13,743,060</td>
<td>($9,521,915)</td>
<td>($95,219)</td>
<td>($52,042)</td>
</tr>
<tr>
<td>Year 3</td>
<td>($9,079,773)</td>
<td>$7,193,847</td>
<td>$16,652,870</td>
<td>($7,659,356)</td>
<td>($76,594)</td>
<td>($45,399)</td>
</tr>
<tr>
<td>Year 4</td>
<td>($8,999,861)</td>
<td>$8,527,611</td>
<td>$20,672,080</td>
<td>($7,462,313)</td>
<td>($74,623)</td>
<td>($44,999)</td>
</tr>
<tr>
<td>Year 5</td>
<td>($9,291,595)</td>
<td>$10,039,350</td>
<td>$25,476,680</td>
<td>($7,156,102)</td>
<td>($71,561)</td>
<td>($46,458)</td>
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<tr>
<td>Year 6</td>
<td>($10,416,580)</td>
<td>$11,717,080</td>
<td>$31,144,630</td>
<td>($6,754,933)</td>
<td>($67,549)</td>
<td>($52,083)</td>
</tr>
<tr>
<td>Year 7</td>
<td>($10,281,890)</td>
<td>$13,628,480</td>
<td>$37,253,310</td>
<td>($6,410,493)</td>
<td>($64,105)</td>
<td>($51,409)</td>
</tr>
<tr>
<td>Year 8</td>
<td>($9,855,405)</td>
<td>$15,744,070</td>
<td>$43,292,900</td>
<td>($5,950,661)</td>
<td>($59,507)</td>
<td>($49,277)</td>
</tr>
<tr>
<td>Year 9</td>
<td>($9,715,582)</td>
<td>$18,018,130</td>
<td>$51,488,910</td>
<td>($5,611,576)</td>
<td>($56,116)</td>
<td>($48,578)</td>
</tr>
<tr>
<td>Year 10</td>
<td>($9,929,715)</td>
<td>$21,618,630</td>
<td>$61,848,370</td>
<td>($3,219,717)</td>
<td>($32,197)</td>
<td>($49,649)</td>
</tr>
</tbody>
</table>

Average ==> $11,504,034

($639,526) ($484,311)
FutureMetrics
We provide expert modeling for developers of pellet export projects.

Maximize the likelihood of success
Minimize the risk of ruin
Thank You

Questions?

William Strauss, PhD

FutureMetrics

Globally Respected Consultants in BioEnergy

www.FutureMetrics.com