Bioenergy: Economics, Environmental Impacts and Sustainability Issues

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Rutgers EcoComplex

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Economics of Bioenergy
## Assumptions for economic analysis of New Jersey bioenergy potential

<table>
<thead>
<tr>
<th>Economic Analysis Issue</th>
<th>Comments</th>
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<tbody>
<tr>
<td><strong>Biomass fuel prices</strong></td>
<td>• The analysis has been conducted using a range of fuel prices depending on the technology/application.</td>
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<td>• In general, each analysis includes a case with zero fuel cost, which would be representative of a situation where opportunity fuels are available (i.e., these fuels would otherwise require disposal. In general a tipping fee has not been modeled since it is assumed that as markets develop for biomass feedstocks, waste materials, once viewed as liabilities will be viewed as saleable products.</td>
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<td>• $3/MMBtu (~$45-50/dry ton for most biomass) is generally assumed as a high-end for biomass feedstocks. For biomass that is produced and used at the same location, a lower price of $1.50/MMBtu has been assumed, which is representative of the opportunity cost of not selling that biomass into the market.</td>
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<td>• Where waste is the primary feedstock (e.g., food waste from MSW), a tipping fee has been assumed. This tipping fee is lower than current values in New Jersey assuming that as demand for these feedstocks rise, this will increase their value and result in lower tipping fees.</td>
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<td>• For corn-ethanol and soy-biodiesel, feedstock prices cover a range typical for these agricultural commodities.</td>
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<td><strong>Project scale</strong></td>
<td>• Project scale will be highly dependent on the availability of biomass at a specific site and the cost to deliver it to that site.</td>
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<td>• The analyses presented here are for “typical” plant sizes and the resulting production costs should therefore be viewed as indicative of the application vs. definitive. Projects that will be typical of the New Jersey setting may be different than those assumed here.</td>
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<td><strong>Technological maturity</strong></td>
<td>• For emerging technologies, published cost and performance data are typically only available for mature (“Nth plant) technology, assuming cost reductions and performance improvements associated with successful commercialization.</td>
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<td>• As such cost and performance data for near-term deployment are not available. These costs have been estimated assuming reasonable scaling factors and best judgment.</td>
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Biopower Production Projections

New Jersey’s estimated practically recoverable biomass resource of 5.5 MDT could deliver up to 1,124 MW of power, (~9% of New Jersey’s electricity consumption) if appropriate technologies and infrastructure were in place.

Total biopower potential is estimated to increase from 1,124 MW in 2007 to 1,299 MW by 2020, a ~16% increase.
Some biopower technologies are becoming cost competitive. Economics are driven by feedstock cost, incentives, technology type.

By 2015, cost reduction potential should bring additional biopower technologies into the realm of commercial application.

**Comparison for Biomass Power Options: 2007 with and without incentives**

<table>
<thead>
<tr>
<th>Feedstock Cost</th>
<th>DC - Central</th>
<th>DC - CHP</th>
<th>CHP - Combined Heat and Power</th>
<th>IC - Internal Combustion</th>
<th>IC Engine</th>
<th>AD - Anaerobic Digestion</th>
<th>LFG - Landfill Gas</th>
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1: in $/MMBtu (unless specified)
2: net cost relative to displaced coal
3: assumes a $40/ton tipping fee to producer
* Separate feed. No incentives available

Range of possible additional capital charges, depending on depreciation status of host coal plant.

Cost of energy from a new conventional power facility.

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Biofuel Production Projections

New Jersey’s estimated practically recoverable biomass resource of 5.5 MDT could deliver up to 311 million gallons of gasoline equivalent (~5% of transportation fuel consumed) if appropriate technologies and infrastructure were in place.

Total biofuel potential is estimated to increase from 311 M GGE in 2007 to 335 M GGE by 2020, an ~8% increase.
- Incentives, feedstock costs, and possible tipping fees are also a key to promoting the production of biofuels.
- Major cost reductions are expected over the next 3-8 years that should allow new biofuels technologies to become more cost competitive.

**Fuel Production Cost Comparison for Biofuels Options: 2010 & 2015 with and without incentives**

1: in $/ton of biomass (unless specified)
2: assumes $40/ton tipping fee to producer
3: in $/bushel of corn
4: in $/gallon of vegetable oil
* 2010 costs are extrapolated by linear interpolation of 2007 and 2015 costs

Note: any incentives included are those that apply to producers (i.e., they affect production costs). Blenders excise tax credits, which affect market prices, are not included.
Emerging biofuels technologies can provide New Jersey an opportunity to become a recognized leader in biofuels in the future.

- New Jersey has enough biomass resources that are suitable to produce cellulosic ethanol, Fischer-Tropsch liquids, and other 2nd generation biofuels to achieve meaningful economies of scale, and additional resources might be collected in neighboring states.

- However, some of these technologies are not yet commercially available
  - Current costs are not competitive with either gasoline or corn ethanol and technology development and demonstration are still needed
  - The first commercial plants will face significant technology, development and market risks and will need government support to “get steel in the ground”
  - While the federal government has already put in place mechanisms for supporting this new industry (such as grants, loan guarantees, RFS carve-outs), New Jersey could add its support to become a recognized leader in these technologies.
Environmental Impacts
Measuring Environmental Impacts

- Inexpensive agricultural materials will play a key role in catalyzing the growth of new and existing biofuel industries
- *We have a unique opportunity to design these industries for better environmental performance*
- One important tool: life cycle analysis (LCA)
- LCA has great value if used properly, but it is a limited tool
- LCA exists to *make comparisons*…*LCA should* not be done in the ideal or the abstract
Life Cycle Assessment Models

What Are Life Cycle (LCA) Models?

• Full system studies of material/energy inputs & outputs for both products & processes

• Inventory environmental impacts of products & processes (many possible impacts, select “key” ones)

• Objectives:
  – Benchmark, evaluate & improve environmental footprint
  – Compare with competition or alternatives
  – Comply with regulations, inform public policy
  – Eventually to meet consumer expectations?

• Relatively new field—”born” about 1990-still being developed

• Allocation issues in LCA are both important and controversial
Some Life Cycle Assessment Standards:

• Use the most recent/most accurate data possible
• Select the reference system/functional unit: what exactly are we comparing?
• Make it easy for others to check your data and methods = transparency
• Set clear system boundaries (physical & temporal)—must be equal or comparable for reference system and/or reference product of interest
• Multi-product systems must allocate environmental costs among all products
• Perform sensitivity analysis: how much do results vary if assumptions or data change?
Select the reference system or functional unit: what exactly are we comparing?

- Ethanol vs. Gasoline?

- Corn ethanol vs. cellulosic ethanol vs. tar sands “oil” to gasoline?

- Backwards looking or forward looking (temporal boundaries)?

- Corn for ethanol vs. corn for animal feed?

- Allocation can be impacted by preference for feed vs. fuel uses of corn in terms of land use change allocations
Sustainability Issues
LCA should be a component of sustainability, not vice versa.

LCA is a tool for comparing alternatives - helps identify “best” use based on environmental impacts – is recycling, bioenergy or land filling a better option for waste products? Issues: Objective – fossil energy savings, efficient use of resources, GHG reduction, costs, System boundaries; Time horizon; Base case fossil fuels – expected level of penetration?

The BIG Challenge:
How to find the best compromise between credibility, complexity and reality?
Things to Consider in Developing Sustainability Standards*

- Establishing a screening criteria to determine compliance with standards means that applicants must submit enough information to know if a “sustainability test” has been met-
  - Reasonable Constraints
  - Undue Burden on Emerging Technologies?
- How Much Better is Best? = Thresholds
  - Better Than Current Practices for Non-Sustainable Industries?
  - No Net Loss or Change from Status Quo?
  - No Unacceptable Change?
  - Biofuel Production may mean using more resources:
    - Land, water, fertilizer, chemicals, labor, energy
- Is a sustainable practice different than current regulatory standards? Does compliance equal sustainability? Particularly relevant to social justice standards.

- What are the economic implications of the standards? Market impacts?
- What are the technological hurdles to achieving the standards?

*California Energy Commission, 2008
More Things to Consider*

• What is the boundary of the physical, geographic or social system?
• What is the timeline for the system we are considering: one year, 50 years?
• Scale Issues:
  – GHG emissions are global pollutants
  – Water use is regional
  – Wastewater discharge may be a localized issue
  – Indirect land use changes are global, regional and localized
• How much of what information is needed to determine if an alternative fuel or vehicle technology is “sustainable?”
• Who provides the information and analysis?
• Do information claims on sustainable products and processes need to be certified by third parties?
• Are all metrics and parameters given equal weight, or are some more important than others?

Remember: Information costs money to compile and manage

*California Energy Commission, 2008
Vision for the Future

- A viable, sustainable domestic biomass industry that
  - Produces renewable biofuels, bioproducts and biopower,
  - Enhances U.S. energy security
  - Reduces our dependence on oil
  - Provides environmental benefits including reduced greenhouse gas emissions, and
  - Creates economic opportunities across the nation.

Social  Environmental  Economic