James Primrose

BioEnergy Case Study

A Sugarcane Ethanol Plant in Brazil

World Bank, Washington
25th March 2014
What will we do in this session?

• Introduce a hypothetical Brazilian Sugarcane Ethanol Case Study

• Objectives:
  – Provide an outline on how the UNFC classification might work in a Bioenergy scenario.
  – Demonstrate the key decision points that need to be considered.
  – Trigger discussions: classification may sometimes be subjective.
  – Identify specific Bioenergy issues that need to be addressed in the Bioenergy Specification document (Phase 2).
Sugarcane ethanol mill

Pre-processing
- Cane harvest
- Delivery & sampling
- Unloading
- Cane preparation
- Juice extraction

Processing
- Juice treatment & filtering
- Evaporation
- Ethanol production
  - Fermentation
  - Distillation & Dehydration
  - Storage
  - Truck loading
- Sugar production
  - Cooking & crystallization
  - Centrifuging & drying
  - Bagging

Ethanol production
- 100 - 200 million litres of ethanol per year

Sugar production
- 170 - 340 kt of sugar per year

Juice is converted sugar and ethanol (50:50 split)

Sugarcane input: 2.5 mtpa capacity, with expansion to 5 mtpa

Steam & Power Generation
- Bagasse residue
- High-pressure boiler
- Power and steam for process energy

Power export
Sugarcane Ethanol Project: Usina BioSucro

• **Existing 2.5 Mtpa Crush Capacity Mill.**
  – Start-up 2008. Expected economic life-time 30 years (to 2038).
  – Produces typically a 50:50 split of ethanol (~100 mill litres) and sugar (170 ktpa).
  – Ability to swing production 60:40 either way.
  – Surplus power from cogen export to grid.
  – 90% of cane from a portfolio of land leases.
  – Average lease lifetime ~ 10 years/maintained on a rolling basis.
  – 10% cane from out-growers – annual contracts.

• **Sanctioned Project to expand capacity at mill to 5 Mpta.**
  – Planned commissioning date 2015 harvesting season. Project currently 70% mechanically complete.
  – Expected Economic Lifetime 30 yrs (to 2045).
  – Planned 50:50 ethanol/sugar split with ability to swing 60:40 either way.
  – Increased cogen, increased power exports to grid.
  – 90% : 10% leased : out-grower cane. Same average lease lifetime 10yrs.
  – Cane planting underway.

• **Product Monetization.**
  – Ethanol 80:20 split of sales to domestic market and for export.
  – Sugar: Mixture of sales via a broker and direct to end-users – annual contracts.
  – Power: Mixture of spot and auction contracts.
# Key decisions

<table>
<thead>
<tr>
<th>Reference Point</th>
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<tr>
<td><strong>Marketable Energy Products</strong> Ethanol, and Power</td>
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<tr>
<th>What about the sugar? (non-energy product optionality)</th>
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<tbody>
<tr>
<td><strong>Sugar output is not counted</strong> (however options to swing/convert sugar to ethanol production are considered as lower probability / confidence reserves)</td>
<td></td>
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<table>
<thead>
<tr>
<th>Can we count the energy used in the process?</th>
<th></th>
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<tbody>
<tr>
<td><strong>Yes</strong> - power and heat generated for process energy is counted, but treated as non-sales (E3.1).</td>
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<table>
<thead>
<tr>
<th>What units do we use?</th>
<th></th>
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<tbody>
<tr>
<td><strong>Wait for conversion document for all renewables</strong></td>
<td></td>
</tr>
<tr>
<td><strong>For now, using barrels of ethanol (bbl) and terawatt-hours (TWh) heat and power</strong></td>
<td></td>
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Project maturity relies on evidence of technical and commercial maturity

- **Feasibility Criteria (F-axis)**

- **Socio-economic criteria (E-axis)**
  - Access and entitlement
  - Market and sales connectivity
  - Authorisation and commitment
  - Economic case validation

*All* of these criteria must be satisfied together.
Access and entitlement

• Is there evidence of access or entitlement to the land on which to grow the sugarcane?

• None of the feedstock is from land owned by the plant owner

• 90% of the feedstock is from leased land
  – Current lease length → High confidence / Commercial Project
  – Lease extensions → Moderate confidence / Commercial Project
  – Likely future lease renewal
    Non yet Commercial Project. → Moderate to Low confidence. Commercial to

• Treatment / evidence base required to assess the certainty of lease renewals/ extensions ?

• Treatment of the 10% sourced from out-growers ?
General Bio-Energy Entitlement Issues

- Multiple business models exist to access biomass for bioenergy.
  - **Land Equity.** Plant Operator owns and produces the biomass feedstock.
  - **Lease.** Plant operator leases the land and either cultivates the biomass directly or contracts to a 3rd party.
  - **“Stumpage”.** Similar to lease. An operator has the right to remove a waste/residue. Typically applies to forestry, but could apply to other ag wastes.
  - **Sourced from Market:** Operator feedstock from market. Covers spot purchase to LT supply contracts.

- Treatment of lease extensions / lease renewals.
  - Classification treatment depends on degree of certainty around extension/renewal. E.g. contractual clauses, historical track record.

- Treatment of biomass sourced from market.
  - Different treatment between spot and LT supply contracts?
  - Can entitlement ever be considered for spot supplies?
Market and sales connectivity

- Are the conversion plant, storage and transport infrastructure in place to convert feedstock into an energy product? For how long?

- Technical lifetime of the conversion plant (30 years) → **Commercial project – high confidence**

- Lifetime extension by capex reinvestment → **Not yet commercial project**
Authorisation and Commitment

• Is sanction / financial approval to develop the plant in place, including from any JV partners?

• Current plant is already operating → Commercial project – high confidence

• An expansion of plant capacity is currently in the final stages of the approval process → Commercial project – high confidence

• Note that economically viable upgrades / technology enhancements, that are not yet sanctioned would go into Not yet commercial
Economic case validation

• Is there an economic model demonstrating commerciality?

• If this depends on policy support, what is the lifetime of the policy?

• The plant is commercially viable and no policy support is required → Commercial project – high confidence
The category also depends on the level of certainty and evidence to support this

• Volumes with lower certainty, are put into the commercial projects - moderate confidence category, e.g.

• Plant efficiency improvements with learning
  • Average crop yield improvements
  • Swing towards ethanol

• If large scale investment and or a technology breakthrough is required to access additional production → ‘not yet commercial’ category

• Clearly there some ambiguity exists at the margins between the categories. The guiding principle is the strength of the demonstrable evidence.
## Example Results

<table>
<thead>
<tr>
<th>Category</th>
<th>Project</th>
<th>Sales</th>
<th>Non-Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ethanol M bbl</td>
<td>Power TWh</td>
</tr>
<tr>
<td>Commercial project High Confidence</td>
<td>Existing plant (10 yr lease)</td>
<td>6.3</td>
<td>1.7</td>
</tr>
<tr>
<td>111, 112, 113</td>
<td>Expansion (10 yr lease)</td>
<td>6.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Potentially Commercial Project</td>
<td>Improved crop yields (ATR +5 kg/te cane)</td>
<td>0.8</td>
<td>0.03</td>
</tr>
<tr>
<td>Moderate Confidence 221 222 223</td>
<td>Lease extension (existing + expansion 1 yr)</td>
<td>1.2</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Lease renewal (up to 30 yrs)</td>
<td>21</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>Increase ethanol to 60% (30 yrs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non Commercial 321 322 323</td>
<td>Increase ethanol to 100% (30 yrs)</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>One additional plant lifetime (30 years) at 100%</td>
<td></td>
<td>76</td>
</tr>
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Conclusions

- UNFC framework suitable for the classification of Bioenergy resources.
- Key considerations (methodology design decisions) are:

1. **Reference Point: “Marketable Energy Products” Definition.**
   - Is wood an energy product?

2. **Entitlement / Access to the biomass feedstock.**
   - Treatment of volumes sourced from the market?
   - Treatment of lease extension / renewal?

3. **Market connectivity - how do we define/limit plant lifetime?**

4. **Treatment of energy used in process.**

5. **Treatment of non-energy co-products?**
   - Particularly where there is an option to swing production between energy and non-energy products.

6. **Unit Conversion**
   - Mbbl to Mboe ?
   - Twh to xxx?
Back - Up
### Bioenergy Value Chains (1)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Points to consider</th>
</tr>
</thead>
</table>
| **Grain ethanol plant**    | - Plant owner contracts for grain supply with individual farmers annually and with a trader annually  
                              - Produces ethanol + animal feed                                              | - Who can claim reserves  
                              - Production of non-energy co-products  
                              - Proving access to feedstock  
                              - Proving future market connectivity given changing policy climate            |
| **Vegetable oil biodiesel plant** | - Plant owner contracts for vegetable oil with a cooperative annually, and buys on the spot market  
                              - Produces biodiesel. This involves using non-renewable methanol              | - Who can claim reserves  
                              - Proving access to feedstock  
                              - Proving future market connectivity given changing policy climate  
                              - Use of non-renewable input                                                  |
| **Sugarcane ethanol plant** | - Plant owner leases land from landowners to grow cane, and buys cane on the spot market  
                              - Cane is used to produce sugar, ethanol and power                             | - Who can claim reserves  
                              - Proving access to feedstock  
                              - Production of non-energy co-products                                         |
# Bioenergy Value Chains (2)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Points to consider</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Woodchip co-firing plant</strong></td>
<td>• Coal plant owner contracts for supply of woodchips for 20 years&lt;br&gt;• These are co-fired with coal to produce power</td>
<td>• Who can claim reserves&lt;br&gt;• Proving access to feedstock&lt;br&gt;• Proving future market connectivity given changing policy climate</td>
</tr>
<tr>
<td><strong>Waste CHP plant</strong></td>
<td>• Plant contracts with waste management company for waste supply over 20 years&lt;br&gt;• Produces heat and power</td>
<td>• Who can claim reserves&lt;br&gt;• Proving access to feedstock&lt;br&gt;• Changing feedstock quality</td>
</tr>
<tr>
<td><strong>Forestry residue pellet plant</strong></td>
<td>• Large forestry owner sites a pellet plant at their forest. Also contracts additional feedstock from a neighbouring forest owner on a 10 year contract&lt;br&gt;• Produces pellets, sold to a distributor then to multiple small users and one power plant</td>
<td>• Who can claim reserves&lt;br&gt;• Proving access to feedstock&lt;br&gt;• Proving market connectivity</td>
</tr>
</tbody>
</table>