Developing and testing standards for biomass energy in ASEAN and East Asia

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In 2007, Economic Research Institute for ASEAN and East Asia (ERIA) WG for “Sustainable Biomass Utilisation Vision in East Asia”

The WG developed the following policy recommendations:

- Addressing macro and micro levels needs to reap maximum economic benefits
- Mitigating negative & enhancing positive environmental impacts
- Realising direct & indirect monetary returns for societal benefit
- Developing sustainability indicators to enhance the decision making process
- Standardising tools to generate quantifiable & verifiable information
- Considering country-specific needs & available biomass resources
- Promoting regional & international cooperation
<table>
<thead>
<tr>
<th>Country</th>
<th>Name</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
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<td><em>WG Leader</em> Masayuki SAGISAKA</td>
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<td>College of Engineering and Agro-Industrial Technology University of the Philippines</td>
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</tr>
<tr>
<td><strong>Japan</strong></td>
<td>Tomoko KONISHI</td>
<td>RISS, AIST</td>
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</tbody>
</table>
Individual Studies for Guideline Development

- Investigation of Guideline for Sustainable Agro-industries Biomass Waste Utilization in Indonesia (ULRI, Indonesia)
- Investigation of Approaches for Environmental, Economic and Social Assessments for Biomass Utilization (JGSEE, Thailand)
- Investigation of Guidelines for Life Cycle GHG Calculation in the Utilization of Biomass for Bioenergy (SIRIM, Malaysia)
- Investigation of Methodologies Used in the Calculation of Indices for Economic Assessment of Biomass Utilization (CDSF, Philippines)
- Investigation of Guidelines for Indicators of Social Impact of Biomass Utilization (NEEF, India)
- Investigation of Guideline to Estimate Bioenergy Production in the Northern Thailand as an Example (CMU, Thailand)

“Sustainability Assessment of Biomass Utilisation in East Asia” in 2008/9
Sustainability indicators

• Environmental Index : Life Cycle GHG
\[ \Sigma EIP = \Sigma (Q(x) \times EF(x)) \]

• Economic Index : Gross Value Added (GVA)
\[ GVA = VA_a + VA_b; \text{ where,} \]
\[ VA_a = GR_a - TC_a; \quad VA_b = GR_b - TC_b; \]
\[ \text{where, GR – Gross or Total Revenue, TC – Total Cost,} \]
\[ a – \text{Main Product,} \quad b – \text{By-products} \]

• Social Index : Human Development Index (HDI)
\[ HDI = \frac{1}{3} (\text{Life expectancy index} + \text{Education Index} + \text{GDP Index}) \]
Life Expectancy Index = \( (\text{LE}-25)/(85-25) \)
Education Index = \( \frac{\text{ALI} \times 2}{3} + \frac{\text{GEI} \times 1}{3} \)
Adult Literacy Index (ALI) = \( (\text{ALR}-0)/(100-0) \)
Gross Enrolment Index (GEI) = \( (\text{CGER}-0)/(100-0) \)
GDP Index = \( \frac{\log(\text{GDPPc}) - \log(100)}{\log(40000) - \log(100)} \)
Pilot Project studies 2009/10

Andhra Pradesh, India
Biodiesel from Oil Trees
(Jatropha, Pongamia, Neem)

Khon Kaen, Thailand
Bioethanol from Sugarcane

Lampung, Indonesia
Biofuels from Cassava & Jatropha

Quezon, Philippines
Biodiesel from Coconut Oil
KHON KAEN SUGAR INDUSTRY PUBLIC CO., LTD. (KSL Group)

Khon Kaen Sugar Industry Public Co., Ltd.
Khon Kaen Sugar Power Plant Co., Ltd.
Khon Kaen Alcohol Co., Ltd. (Ethanol plant and Fertilizer plant)

ESTABLISHED IN 1976
Biorefinery complex (Khon Kaen, Thailand)

- Farmer
  - Sugar Factory
  - Sugar
  - Molasses
  - Ethanol Plant
  - Ethanol (99.5%)
  - Electric
    - EGAT, KKA - KKS
  - Fertilizer
    - Fertilizer Plant
  - Filter Cake; Cane dirties
  - Bagasses; Cane Fiber
  - Steam
    - KKA - KKS

- 70% of cane leaf: Direct burning
- Plantation area: 200,000-300,000 rai
- 80% of raw materials from farmer
- 4,000 contracts: year by year
- 2% of raw materials from factory
- Average distance farms - factory = 50 km
Inventory data collection

• Sugarcane production
  – Fuel, fertilizer, herbicide, cane trash burning

• Sugar/molasses production
  – Production capacity, fuel, electricity use, surplus electricity sold to the grid, chemical use, waste management/utilization

• Ethanol conversion
  – Production capacity, fuel, electricity use, chemical use, waste management/utilization such as biogas

• Biomass power plant
  – Production capacity, fuel use, electricity use, surplus electricity sold to the grid chemical use, waste management/utilization

• Fertilizer production
  – Production capacity, fuel use, electricity use, chemical use, waste utilization

• All transportation activities
  – Distance, transport mode, capacity

The information was collected via questionnaire surveys, interviews, factory reports, literature
Ref. flow: 1 tonne of sugar cane $\leftrightarrow$ 0.1 rai of land $\leftrightarrow$ 15.48kWh of electricity from bagasse $\leftrightarrow$ 14.95 liter of ethanol from molasses $\leftrightarrow$ 0.018 kg of fertilizer from filter cake and spent wash
## Environmental Assessment

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Ethanol (kg CO$_2$e)</th>
<th>Gasoline (kg CO$_2$e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Scenario</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>13.50</td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td>-</td>
<td>21.66</td>
</tr>
<tr>
<td>Total</td>
<td>13.50</td>
<td>26.70</td>
</tr>
<tr>
<td>Scenario 1</td>
<td>0%</td>
<td>35%</td>
</tr>
<tr>
<td>Production</td>
<td>5.91</td>
<td>8.38</td>
</tr>
<tr>
<td>Use</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>5.91</td>
<td>8.38</td>
</tr>
<tr>
<td>Scenario 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>8.38</td>
<td>11.20</td>
</tr>
<tr>
<td>Total</td>
<td>8.38</td>
<td>11.20</td>
</tr>
</tbody>
</table>

**Note:** Results based on reference flow of 14.95L ethanol which is equivalent to 9.89L gasoline

**Scenario 1:** Percentage of cane trash burning (base case is assumed as 70%)

**Scenario 2:** Utilization of excess steam

**Benefits of sugarcane biorefinery:**

- A reduction of GWP by 50% for ethanol as compared to gasoline (Base scenario)
- A further reduction by 70% and up to 80% when cane trash burning is reduced or avoided (Scenario 1)
- A potential additional 10% GHG savings from utilisation of unused steam (Scenario 2)
### Social Assessment

<table>
<thead>
<tr>
<th>Social Assessment</th>
<th>Khon Kaen</th>
<th>Plantation</th>
<th>Bio-energy production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Expectancy at birth Indicator (LEI)</td>
<td>0.728</td>
<td>0.728</td>
<td>0.728</td>
</tr>
<tr>
<td>Education Index (EI)</td>
<td>0.888</td>
<td>0.888</td>
<td>0.888</td>
</tr>
<tr>
<td>GDP Index (GI)</td>
<td>0.673</td>
<td>0.593</td>
<td>0.776</td>
</tr>
<tr>
<td>HDI</td>
<td>0.763</td>
<td>0.736</td>
<td>0.797</td>
</tr>
</tbody>
</table>

**CHANGE IN HDI**

- - 0.027
- + 0.034

#### Farmers – sugarcane cultivation
- Belong to lower income class of society
- Negative change in HDI (due to lower income than provincial level)
- Benefit form steady income due to contract farming with sugar mill

#### Employees – biorefinery complex
- Higher income than average at provincial level
- Positive change in HDI
- Better living conditions due to employment at biorefinery complex
## Economic Assessment

<table>
<thead>
<tr>
<th>Economic Assessment</th>
<th>System studied</th>
<th>Total Value Added (TVA) (THB/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plantation (THB/Year)</td>
<td>Khon Kaen Biorefinery complex (THB/Year)</td>
</tr>
<tr>
<td>Total Net Profit</td>
<td>393,681,432</td>
<td>956,712,601</td>
</tr>
<tr>
<td>Wages Paid</td>
<td>708,125,095</td>
<td>760,810,000</td>
</tr>
<tr>
<td>Tax Revenue</td>
<td>13,625,940</td>
<td>357,494,553</td>
</tr>
</tbody>
</table>

**TOTAL VALUE ADDED**: 3,190,449,621

### Sugarcane plantation:
- Salaries to farm laborers represent 64% of TVA
- Profits from selling sugarcane to the mill represent 35% of TVA
- Taxes represent only 1% of TVA

### Biorefinery complex:
- Profits represent 46% of TVA
- Salaries represent 37% of TVA
- Taxes represent 17% of TVA
Observations on the use of the guidelines

• Indicators like GHG savings; total value added (TVA); and human development index (HDI) could be used for assessing the sustainability of biomass energy.

• Establishment of baseline for HDI is quite difficult; interpretation of results should be done in conjunction with economic indicator.

• For sustainability assessment of complex systems, expertise is needed as data collection and processing can be quite complicated. Training is recommended in order to apply the guidelines properly.
Recommendations for further study

- **Environment**: Impact categories such as land use change, acid rain, eutrophication, ecotoxicity, human toxicity and resource depletion may also be relevant as they affect the locality where the emissions or depletion occur.

- **Economic**: There should be a business component throughout the value chain and net profit is positive.

- **Social**: Although HDI is widely applied to evaluate social impact at state, regional or national level, there is a need to develop an index or some indices that can better represent social impact at the community level.
  - Job creation, access to modern energy and energy security are proposed as indicators to be considered further.
Results of Pilot Projects are in the appendices

Appendix 1 Pilot Project Report in Lampung, Indonesia
Appendix 2 Pilot Project Report in Quezon, the Philippines
Appendix 3 Pilot Project Report in Khon Kaen, Thailand
Appendix 4 Pilot Project Report in Andhra Pradesh, India

Available at http://www.eria.org/research/y2009-no12.html
THANK YOU

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