AGRI + CHEMICAL PROCESS: Biogas Technology for 1.5\textsuperscript{th} - 2\textsuperscript{nd} Gen Biomass

July 2015
Agenda

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1. About IHI Enviro

- Trade Name: IHI Enviro Corporation
- Head Office: Tokyo, Japan
- Date of Establishment: July, 1984
- Capital: JPY200 m (USD2 m)
- Employees: 654 (March 2014)
- Annual Turnover:
  - 2006 - JPY14.0 b (USD140 m)
  - 2007 - JPY14.7 b (USD147 m)
  - 2008 - JPY17.3 b (USD173 m)
  - 2009 - JPY17.3 b (USD173 m)
  - 2010 - JPY13.8 b (USD138 m)
  - 2011 - JPY14.3 b (USD143 m)
  - 2012 - JPY17.8 b (USD178 m)
  - 2013 - JPY16.8 b (USD168 m)
IHI views biomass and renewables as one of its strategic business areas for the future.

- Biomass Gasification (TIGAR)
- Biofuels from Microalgae
- AGRI+Chemical
2.1 Environmental Issues

Water pollution by Palm Oil Mill Effluent (POME)

Soil pollution by waste Oil Palm Trunk (OPT)

CH4 emissions and Odour from Cassava pulp,

Greater Environmental Impact

Conversion to sustainable agriculture by reducing environmental impact

Energy Policy to utilize unused biomass

- Huge amount of biomass generated from various industries are still untapped
- The biomass has the potential to be converted into huge amount of renewable energy
- Treating this biomass could reduce environmental impact and at the same time could contribute to energy sector

Fact about the potential of palm industry in Indonesia and Malaysia:
- Size of palm plantation area = 3 times of Tokyo Kanto Area (9.1 \times 10^5 \text{ km}^2)
- Size of palm tree cutting area = 2 times of Tokyo Metro (0.46 \times 10^5 \text{ km}^2)
- BOD load in POME = 12 times of sewage treatment in Tokyo Metro (3.57 \text{ Mton-BOD/y})
- Unused energy hidden in biomass \approx Energy of natural gas supplied by Tokyo Gas (4,538 \text{ M-Nm}^3 /y)
2.1 RE Opportunities in SE Asia

Alternative Energy Development Plan (AEDP)
Target of 25% renewable energy by 2021

Solar
- 3,000 MW (Power)
- 100 ktoe (Heat)

Wind
- 1,800 MW (Power)

Small/Mini Hydro
- 324 MW (Power)

Bioenergy
- Biomass
- Biogas
- MSW
- 8,500 ktoe (Heat)
- 1,000 ktoe (Heat)
- 200 ktoe (Heat)

Biofuels
- Bioethanol: 9,000,000 Litre/day
- Biodiesel: 7,200,000 Litre/day
- Next Gen Biofuels: 3,000,000 Litre/day
- CBG: 1,200 t/day

Others
- Tidal/Wave: 2MW
- Geothermal: 1MW

Motivation:
- Large Biomass Potential and diversity
- Supportive Government policies and FIT rates

Challenges:
- Existing methods fail to utilize full biomass energy potential
2.2 Our Missions

1. To contribute to the society by reducing environmental impact
2. To fully utilize the untapped potential of biomass (1.5\textsuperscript{th} - 2\textsuperscript{nd} Generation Biomass) by using Agri+Chemical Process
3.1 Introduction of **AGRI+CH\textsubscript{4}EMICAL**

- New business model to create different kinds of renewable energies from methane derived from biogas generated by IHI-IC reactor such as follows:
  - Power (electricity)
  - Solid fuel (pellet etc.)
  - Biofuels (via GTL technologies)
  - Compressed Natural Gas (CNG)
  - Hydrogen (steam reforming), etc.
- The focus is on unused 1.5\textsuperscript{th} – 2\textsuperscript{nd} Generation Biomass like cassava pulp, oil pump trunk (OPT), bagasse etc.
- Key technologies:
  - IHI-IC Reactor (IHI Enviro)
  - Biological saccharification of lignocellulose biomass (KMUTT + JIRCAS)

**Example: Agri+Chemical for palm industry**

1. Palm Oil Plantation
2. Old Palm Trunk → Sap Juice
3. Felling → Pressing → Palm Bagasse
4. Sap Juice → Molasses → Cellulose Saccharification
5. Molasses → Cellulose → IHI-IC Reactor
6. IHI-IC Reactor → CH\textsubscript{4}
7. CH\textsubscript{4} → GE & Cogen Facility
8. GE & Cogen Facility → Power → Hot Water
9. CH\textsubscript{4} → IHI-Reformer
10. IHI-Reformer → GTL etc.

Example: Agri+Chemical for Palm industry

- FFB → CPO → Cellulose
- POME → Molasses → Saccharification

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### 3.1 Introduction of AGRI+CH4EMICAL

<table>
<thead>
<tr>
<th>Industry (Target Biomass)</th>
<th>Liquid Biomass</th>
<th>Solid Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm</td>
<td>POME / Sap juice</td>
<td>OPT / Palm bagasse</td>
</tr>
<tr>
<td>Cassava (starch)</td>
<td>Wastewater (washing)</td>
<td>Cassava pulp</td>
</tr>
<tr>
<td>Sugar (Sugarcane)</td>
<td>Waste molasses</td>
<td>Bagasse</td>
</tr>
<tr>
<td>Brewery</td>
<td>Wastewater (production)</td>
<td>Residues in husking wheat, Waste yeast</td>
</tr>
<tr>
<td>Paper/Pulp</td>
<td>Wastewater (production)</td>
<td>Waste pulp</td>
</tr>
<tr>
<td>Shochu (Japanese alcohol)</td>
<td>Shochu lees</td>
<td>Sweet potato pulp</td>
</tr>
</tbody>
</table>

**What's new?**

This new technology makes it possible to reuse these solid biomasses effectively by cellulose saccharification and create renewable energy from derived methane (CH4).

Recycling of these solid biomasses have not been developed before.

Diagram:

1. **Cellulose Saccharification**
2. **IHI-IC Reactor**
3. **Renewable Energy (CH4)**

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3.2 Basic concept of the process

Organic Wastewater

Liquid-Type Biomass

IHI Enviro

IC Reactor

Methane Fermentation

Key

Power Gen /GTL/CNG

Methane Gas Use

Solid Waste

Chipping

Wet Mill + Dehydration

Micro-organism Saccharification

Key

Solid-Type Biomass

Crushing, Grinding

Pre-Treatment

Hydrolysis

Lignin Hemicellulose Cellulose

IHI Enviro

IHI GROUP

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3.3 Introduction of Key Technology: IHI-IC Reactor
4. Overview of KMUTT-JIRCAS-IHI Partnership

Research collaboration
More effective
More productive
More capable
More Controllable

Biogas (Methane)
GTL
CNG
Water-treatment

Methane platform

Agrichemical process
Sustainable and economical renewable energy production

Biological saccharification
Biotechnol Biofuels. 2013
Biofuels and Bioplastic

JIRCAS
KMUTT
KMUTT
IHI Enviro
Joint Research Agreement between (JRA) between KMUTT-JIRCAS-IHIE signed on 20 May 2015

Article in The Nation Thailand (5th June 2015)
5. Concluding Remarks

- SE-Asian countries such as Thailand are ideal for testbedding new solutions for renewable energy, due to the availability of different kinds of biomass
- Rely on a local partner e.g. Academia who have a deep understanding of local environment and conditions
- Establish win-win partnerships that benefit both private and public entities
Thank you
IHI
Realize your dreams