The Economical and Additionality Analysis of Clean Development Mechanism Biofuel Project in Transport Sector

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1. Introduction

2. Objectives

3. Methodology

4. Results

5. Conclusions
Introduction

Energy Consumption

Final Energy Consumption by Fuel Type 2010

- Petroleum Products: 46.4%
- Electricity: 17.9%
- Coal & Its Products: 9.9%
- Natural Gas: 7.0%
- Renewable Energy: 18.8%

* Including fuel wood, charcoal, paddy husk, bagasse, agricultural waste, garbage and bio.

Final Energy Consumption by Economic Sector 2010

- Transportation: 35.2%
- Agriculture: 5.2%
- Commercial: 15.5%
- Residential: 36.4%

* Including manufacturing (25,633 ktoe), mining (118 ktoe) and construction (120 ktoe).

Source: Thailand Energy Statistics 2010

(Preliminary)
Introduction

Alternative Energy Consumption

Source: Thailand Energy Statistics 2010 (Preliminary)
## Emissions of CO₂ per liter type of fuel combustion

<table>
<thead>
<tr>
<th>Emission</th>
<th>CO₂ equivalent (kgCO₂e/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline octane 91</td>
<td>2.02</td>
</tr>
<tr>
<td>Gasoline octane 95</td>
<td>2.02</td>
</tr>
<tr>
<td>Gasohol octane 91</td>
<td>1.97</td>
</tr>
<tr>
<td>Gasohol octane 95</td>
<td>1.97</td>
</tr>
<tr>
<td>Gasohol E 20</td>
<td>1.92</td>
</tr>
<tr>
<td>Gasohol E 85</td>
<td>1.58</td>
</tr>
<tr>
<td>Diesel</td>
<td>2.71</td>
</tr>
<tr>
<td>Diesel B 2</td>
<td>2.70</td>
</tr>
<tr>
<td>Diesel B 5</td>
<td>2.69</td>
</tr>
<tr>
<td>Diesel B 10</td>
<td>2.67</td>
</tr>
</tbody>
</table>

2006 IPCC
Emissions of CO₂ are calculated on the basis of the amount and type of fuel combusted.
Emissions of CO\textsubscript{2} are calculated on the basis of the amount and type of fuel combusted.
Clean Development Mechanism (CDM)

• Described in Article 12 of KP

• Projects in developing countries can earn saleable credits for reducing/avoiding emissions – certified emission reductions (CERs)

• The CERs can be used by countries with commitments under KP toward meeting a part of their targets

• Host countries benefit from sustainable development initiatives

• Project have global reach
  • Result in real, measurable, verifiable, additional emission reductions

Source: Conservation Agriculture Carbon Offset Consultation, West Lafayette, USA
Clean Development Mechanism (CDM)

CDM project cycle

<table>
<thead>
<tr>
<th>Stage</th>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Identification</td>
<td>PIN</td>
<td>Project Identification Note (PIN)</td>
</tr>
<tr>
<td>Project Design</td>
<td>PDD</td>
<td>Project Design Document (PDD)</td>
</tr>
<tr>
<td>Validation/Registration</td>
<td>DOE</td>
<td>Designated Operational Entity (DOE)</td>
</tr>
<tr>
<td>Monitoring</td>
<td>EB</td>
<td>Executive Board (EB)</td>
</tr>
<tr>
<td>Verification/Certification</td>
<td>EB</td>
<td>EB</td>
</tr>
<tr>
<td>Issuance</td>
<td>CER</td>
<td>Certified Emission Reduction (CER)</td>
</tr>
</tbody>
</table>

Technical and financial feasibility
Approved methodology

Source: UNFCCC, adapted by Grütter
What is Additionality in CDM

Without CDM:
Without credits.
Without additional income.
The project may not implement because of barrier.

With CDM:
This is additionality.
With credits.
With additional income.
The project will implement.
**Step 1:** Identification of alternatives to the project activity consistent with current laws and regulations.

**Step 2:** Investment analysis

**Step 3:** Barrier analysis

1. Is there at least one barrier preventing the implementation of the proposed project activity without the CDM; and
2. Is at least one alternative scenario, other than proposed CDM project activity, not prevented by any of the identified barriers?

**Step 4:** Common practice analysis

“If both processes in this step are satisfied, then the proposed project activity is additional.”

“If one of the processes is not satisfied, the proposed CDM project activity is not additional.”
Introduction

Clean Development Mechanism (CDM) in Thailand

Source: Thailand Greenhouse Gas Management Organization (Public Organization)
Objective

To study in comparative analysis of technology and economics including determination of appropriate alternative of technology.

To study in baseline of greenhouse gas emission for clean development mechanism biofuel projects in transport sector.
### Project Type

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Registered PDD</th>
<th>Validation project</th>
<th>Proposed new Methodologies</th>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiesel</td>
<td>1</td>
<td>18</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Ethanol</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>18</td>
<td>11</td>
<td>19</td>
</tr>
</tbody>
</table>
Methodology

Calculated GHG emission

- Production of biodiesel for use as fuel
- Baseline methodology for the production of sugar cane based anhydrous bio-ethanol for transportation using LCA.
- Baseline methodology for the production of starch based anhydrous bio-ethanol that comes from cultivating renewable biomass for transportation using Life Cycle Assessment (LCA).
Methodology

Economic Analysis

**Economic**

- **Payback Period (PP)**
- **Net Present Value (NPV)**
- **Internal Rate of Return (IRR)**

Where:
- $R_n =$ Revenue in year $n$
- $C_n =$ Costs in year $n$
- $n =$ Project period
- $i =$ Discount Rate = IRR
- $TIC =$ Total initial cost

**NPV**

$$NPV = \sum_{n=0}^{N} \frac{R_n - C_n}{(1 + i)^n} - TIC$$

**NPV**

$$NPV = \sum_{n=0}^{N} \frac{R_n - C_n}{(1 + i)^n} - TIC = 0$$
<table>
<thead>
<tr>
<th>Project Type</th>
<th>Host Party</th>
<th>Benchmark Type</th>
<th>Benchmark Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiesel (Data from registered PDD)</td>
<td>Paraguay</td>
<td>Commercial lending rate</td>
<td>7.50%</td>
</tr>
<tr>
<td>Biodiesel (Data from validation PDD)</td>
<td>China</td>
<td>Economic Evaluation Methods and Parameters for Construction Projects (Version 3)</td>
<td>12.00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The project feasibility study report 13 (FSR)</td>
<td>13.00%</td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>Economic Assessment methods and parameters for newly-built project (3rd edition)</td>
<td>13.00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>issued by NDRC and Ministry of Construction in 2006</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bank of India</td>
<td></td>
<td>11.00%</td>
</tr>
</tbody>
</table>
Emissions of CO₂ are calculated on the basis of the amount and type of fuel combusted. The approach is represented in Equation

\[ Emission = EF_i \times Fuel \_consumption \]

Where:
- Emission = Emissions of CO₂ (kg)
- Fuel consumption = fuel sold (TJ)
- \( EF_i \) = emission factor (kg/TJ)
- \( i \) = type of fuel
33 biodiesel industries

- Transesterification (Supercritical): 13%
- Transesterification (Acid catalyst): 6%
- Transesterification (Alkaline catalyst): 56%
- Esterification: 19%
- Two stage: 6%

Biodiesel & Ethanol Production Technology
Ethanol Production Technology

- Batch with Pervaporation membrane distillation: 11%
- Acid hydrolysis with Molecular sieves: 11%
- SSF with Molecular sieves: 78%

9 Ethanol industries
Biodiesel Production

Economic

Result

Esterification

W/O CDM = -11.00 - 5.47
W CDM = 9.59 - 15.18

1 CERs = 10 Euro/tCO$_2$e
Biodiesel Production

Economic

Transesterification (Supercritical)

W/O CDM = 35.98 – 38.22
W CDM = 39.05 – 41.12

1 CERs = 10 Euro/tCO₂e
### Result

**Biodiesel Production**

#### Economic

#### Transesterification (Alkaline Catalyst)

<table>
<thead>
<tr>
<th></th>
<th>Without CDM</th>
<th>With CDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiesel Production</td>
<td>18.63 – 24.30</td>
<td>20.13 – 31.10</td>
</tr>
</tbody>
</table>

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The graph shows the Internal Rate of Return (IRR) for different capacities of the plant. The red line represents the scenario without CDM, and the black line represents the scenario with CDM.

- **Without CDM**: The IRR ranges from 18.63% to 24.30% as the capacity increases.
- **With CDM**: The IRR ranges from 20.13% to 31.10% as the capacity increases.
## Ethanol Production

### Economic

**SSF with Molecular Sieves**

<table>
<thead>
<tr>
<th>Plant Capacity (l/y)</th>
<th>Without CDM</th>
<th>With CDM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W/O CDM = 5.90 – 24.33</td>
<td>W CDM = 11.31 – 26.32</td>
</tr>
</tbody>
</table>

### IRR (%)

- Without CDM: 0.00% – 10.00%
- With CDM: 0.00% – 15.00%

**1 CERs = 10 Euro/tCO₂e**
The most common technology is Trans-esterification (Alkaline Catalyst) which used 56% of the 31 biodiesel industries.

The economic analysis found that after participated CDM implementation the IRR would increase about 9 - 19%.

Trans-esterification (Alkaline Catalyst) is a low costs technology when compared with other technologies.
Conclusions

The most common technology are SSF with Molecular sieves technology which used 78% of the 7 ethanol industries.

The economic analysis found that after participated CDM implementation the IRR would increase about 2 - 6%.

SSF with Molecular sieves are medium cost technology when compared with other technologies.
Thank You
For Attention