Development of Low Carbon Society Scenarios for Asian Regions

DEVELOPING MALAYSIA’s LOW CARBON SOCIETY (LCS) VISION 2020 and 2030

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## Results of main variables

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Population</strong></td>
<td>26.1</td>
<td>32.8</td>
<td>37.3</td>
<td>1.3</td>
<td>1.4</td>
<td>1.6</td>
<td>1.7</td>
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<tr>
<td><strong>Household</strong></td>
<td>5.8</td>
<td>8.2</td>
<td>9.3</td>
<td>1.4</td>
<td>1.6</td>
<td>1.8</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>GDP</strong></td>
<td>509</td>
<td>996</td>
<td>1,601</td>
<td>2.0</td>
<td>3.1</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Per capita GDP</strong></td>
<td>19.5</td>
<td>30.4</td>
<td>43.0</td>
<td>1.6</td>
<td>2.2</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Gross output</strong></td>
<td>1,60</td>
<td>3,13</td>
<td>4,929</td>
<td>2.0</td>
<td>3.1</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Passenger transport</strong></td>
<td>169</td>
<td>315</td>
<td>359</td>
<td>1.9</td>
<td>2.1</td>
<td>1.9</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Freight transport</strong></td>
<td>92</td>
<td>150</td>
<td>214</td>
<td>1.6</td>
<td>2.3</td>
<td>1.7</td>
<td>2.2</td>
</tr>
</tbody>
</table>
Projected output by 26 sectors

Bill. RM

- Public Services
- Other Private Services
- Education, Research & Development
- Accommodation & Restaurants
- Wholesale & Retail
- Real Estate
- Finance & Insurance
- Transport Services
- Water Works
- Electricity & Gas supply
- Construction
- Other Manufacturing Products
- Transport Equipments
- Electric and Electronic Equipments
- General Machinery
- Other Metal Products
- Iron & Steel
- Cement, Ceramic, Stone & Clay Products
- Chemical Products
- Petroleum Refinery & Coal Products
- Paper & Pulp
- Textiles & Wearing Apparel
- Food, Drink & Tobacco Products
- Other Mining
- Oil and Gas Mining
- Agriculture, Forestry & Fishing

Tertiary industries

Secondary industries

Primary industries
Projected transport volume

- Both modal share and transport volume of private vehicle increase in 2020
- Freight transport volume increases proportionally with growth of secondary industries
Projected final energy demand by sectors

- Share of each sector is fit to NC2 in 2020BaU scenario
- The largest energy consumer is industry sector
Projected energy mix of power supply

- Power supply mix is projected to fit **primary supply** of each type of energy in **NC2**
- Coal increase its share significantly in all scenarios
- In 2030CM scenario, share of **renewable energies** reaches nearly 20%.

![Energy mix chart]

- **Coal**
- **Oil**
- **Gas**
- **Hydro power**
- **Solar & mini hydro**
- **Biomass and other renewables**
- **Nuclear**
Projected CO₂ emissions

- In 2020BaU, CO₂ emission doubled from 2005, and tripled in 2030BaU.
- In CM1 scenario, it was reduced by 21%(2020) and 44%(2030) from BaU scenarios.
- In CM2 scenario, it was reduced by 44%(2020) and 55% (2030) from BaU scenarios.
Contribution of mitigation options

- Both in 2020CM and 2030CM, **energy efficiency improvement of commercial sector** has the largest share.
- In 2030CM, **energy efficiency improvement in power supply** is second largest.

![Emission reduction from BaU scenarios](chart.png)

EEI: energy efficiency improvement
Projected GHG emissions (waste)

- In BaU, GHG emission increased more than 2 times in 2020 and 2.8 times in 2030
- In CM1, emission was reduced by 41% (2020) and 68% (2030) from BaU
- In CM2, emission was reduced by 54% (2020) and 74% (2030) from BaU
Contribution of mitigation options

- In S1, CH4 recovery shows the largest contribution
- In S2, recycling is the largest and CH4 recovery is less than S1 because of less CH4 generation resulted from other mitigation options.
Input & output of AFOLU model

Input → AFOLU Emission model → Output

List of Countermeasure
Characteristics of Countermeasure
Scenario of:
- Crop production
- Number of Livestock animals
- Land-use change
- Fertilizer input
- Wood production etc.
- Price of Commodity and Energy
- Yield of crops and Carcass weight of animals
- Production system

Policy;
- GHG emission tax rate
- Energy tax rate
- Subsidy

Emission/ Mitigation
Types of countermeasures
- Cost
- Reduction effect
- Life time/ project period
- Diffusion ratio
- Energy consumption and recovery

- Feeding system of livestock
- Manure management system
- Share ratio of irrigation and rain fed area
Scenario: Harvested area of crops

- Total croplands: 9.8 mil. ha in 2000 → 11.3 mil. ha in 2030
- Yield: 2.5 times from 2000 to 2030 (Hasegawa, 2011)
- Oil palm area is increasing up to 5 mil. ha by 2020 (Wicke et al., 2011).
- Other crops: Extrapolation from 2005 to 2030 using growth ratio from 2005 to 2009
- Fertilizer per area is set based on yield
  - Yield may change depending on Fertilizer input
Scenario: livestock animals

- Base year: NC2
- 2009 (the latest data): FAOSTAT
- 2010 to 2030: increase at ratios in 2005 to 2009
Scenario: land use and land use change

- **Forestland**: NC2 for 2000, 2005, 2009, 2010 and 2020
- **Grassland**: FAOSTAT(2011)
- **Cropland** is total harvested area of crops
- A ratio of *settlements* to total country area:
  - 5.8% in 2008 → 7.3% in 2020 (NPP2)
- **Otherland**: Total Land area - others
Findings from AFOLU model

AFOLU model was applied in Malaysia and estimates GHG emissions and mitigations in AFOLU sectors.

<table>
<thead>
<tr>
<th>Sectors</th>
<th>BaU emissions</th>
<th>Mitigation Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[MtCO2eq/yr]</td>
<td>2020</td>
</tr>
<tr>
<td>Agriculture</td>
<td>7.2</td>
<td>7.9</td>
</tr>
<tr>
<td>LULUCF</td>
<td>-174</td>
<td>-163</td>
</tr>
<tr>
<td>Total</td>
<td>-167</td>
<td>-155</td>
</tr>
</tbody>
</table>

- Countermeasures which have high mitigation potential;
  - Midseason drainage for Agriculture.
  - Reduce impact logging for LULUCF.

* Malaysia NC2, Chap.3, p38, Fig3.4 & Table3.5  
  BaU case
In future scenarios, CO2 emission from cement was increased because of more demand of cement for construction.

CH4 emission from natural gas is almost constant because of assumption of natural gas primary production.
Integration

• Combining all three sectors: Energy, Waste AFOLU and other emission sources

• For AFOLU sectors, $<10 \text{USD/tCO2eq}$ case was applied both for CM1 and CM2 scenarios.
<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2030</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>CM1</td>
<td>CM2</td>
</tr>
<tr>
<td>Diffusion of energy efficient devices</td>
<td>40%</td>
<td>70%</td>
</tr>
<tr>
<td>EEI rate from BaU of thermal power plants</td>
<td>10%</td>
<td>21%</td>
</tr>
<tr>
<td>Modal shift from passenger cars</td>
<td>10%</td>
<td>22%</td>
</tr>
<tr>
<td>Share of bio diesel in transport</td>
<td>2%</td>
<td>6%</td>
</tr>
<tr>
<td>Capacity of RE power plant (MW)</td>
<td>2080</td>
<td>4160</td>
</tr>
<tr>
<td>Recycling rate of solid waste</td>
<td>40%</td>
<td>55%</td>
</tr>
<tr>
<td>Incineration rate of solid waste</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>Recovery rate of CH4 from waste management</td>
<td>25%</td>
<td>35%</td>
</tr>
<tr>
<td>Reduction rate of CO2 emissions from cement production process</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Mitigations in AFOLU sectors</td>
<td>&lt;10USD/kt CO2eq</td>
<td>&lt;100USD/kt CO2eq</td>
</tr>
</tbody>
</table>
- Energy has the largest contribution in both scenarios in all years.
- In BaU scenario, GHG emission increased by 99% (2020) and 174% (2030) from 2005
- In CM1 scenario, it was reduced by 22% (2020) and 42% (2030) from BaU, in CM2, 41% (2020) and 52% (2030).

**GHG emissions**
Emission intensity (GHG emission per GDP)

-22% from 2005

-40% from 2005
Per capita GHG emission

- 2000 (NC2): 9.4 tCO₂eq
- 2005: 10.2 tCO₂eq
- 2020 BaU: 16.1 tCO₂eq
- 2020 CM1: 12.4 tCO₂eq
- 2020 CM2: 9.5 tCO₂eq
- 2030 Bau: 19.5 tCO₂eq
- 2030 CM1: 9.5 tCO₂eq
- 2030 CM2: 9.5 tCO₂eq
Contribution to emission reduction in 2020

CM1
- EEI in demand sectors: 38%
- EEI in power supply: 11%
- Forestry & Landuse: 18%
- Waste: 18%
- Renewable energy: 8%
- Modal shift: 4%
- Agriculture: 1%
- Others: 2%

CM2
- EEI in demand sectors: 32%
- EEI in power supply: 14%
- Forestry & Landuse: 29%
- Waste: 7%
- Renewable energy: 11%
- Modal shift: 5%
- Agriculture: 1%
- Others: 1%
Emissions, sink, and net emissions

![Graph showing emissions, sink, and net emissions from 2000 to 2030.](image)

- Emissions (BaU)
- Emissions (CM1)
- Emissions (CM2)
- Emissions (Actual)
- Net emission (BaU)
- Net emission (CM1)
- Net emission (CM2)
- Net emission (Actual)
- Sink (BaU)
- Sink (CM1)
- Sink (CM2)
- Sink (Actual)
Conclusion

• Target GHGs are: CO₂ from energy use, CO₂ and CH₄ from waste management, CO₂, CH₄ and N₂O in AFOLU sectors
• Modeling result showed that in 2020BaU scenario, GHG emission was doubled from 2005.
• In Countermeasure scenario, GHG emission intensity was reduced by 23% from 2005 in 2020CM1 and 40% from 2005 in 2020CM2 scenario.
• In order to achieve -40% target of emission reduction, more intensive implementation is needed especially in energy sector.
• It is important to note that climate resilient policy strategy is based on balanced development whereby measures need to be balanced with Malaysia’s need to continue to grow to increase its per-capita productivity and income, eradicate poverty and raise living standards.
• Apart from mitigation measures, Malaysia also focuses on adaptation effort that builds resilience against potential impacts.