Indonesia Low Carbon Development Strategy Scenario 2050 in Energy Sector

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Outline:

- Introduction
- Methodology
- Results and Discussion
- Conclusion
Introduction

- Low Carbon Development/LCD is Long Term Vision of Economic Development in a Low-carbon Way ➔ Challenge for achieving LCD is now in a global mainstream, there is no turning back in this trend.

- LCD is relatively new in Indonesia ➔ Current government plans on energy sector are not developed to achieve LCD, but still in lined with and supportive to LCD.

- In the current energy supply mix, the role of new-renewable energy is still low. The energy supply (2000-2005) still relies on oil (54.8%), natural gas 22.2%, coal 16.8%, hydro 3.7%, and geothermal 2.5%.

- GHG emissions in energy sector increased from 50.5 million Ton C (2000) to 82 million Ton (2005). At this level energy sector is the second contributor of national GHG emission after AFOLU (agriculture, forestry, and land use).
- Indonesia is the world’s 10 largest GHG emitters: 1,377 MTon CO$_2$eq (2000) and 1,991 MTon CO2-eq (2005); with the rate 5.7%/year;
- In 2005, the total of CO$_2$ emission of the country is 1.99 GTon CO$_2$e, in which 56% is from AFOLU (includes peat fire), 18.5% is from energy, and the rest is from waste and industrial processes;
- Government of Indonesia (GOI) has announced ‘Non-binding’ GHG reduction target of 26% lower than the baseline of 2020 (domestic budget) and further increased to 41% (international support);
- Indonesia is developing National Action Plan (NAMAs, National Appropriate Mitigation Actions) on GHG Reduction (2010-2020).
- GHG reduction primarily will be achieved by forestry/peat sector, followed by energy, waste, and industrial sectors.
Indonesian Position in World GHG Emitters

China 6.1 Gt, Japan 1.2 Gt, and India 1.3 Gt

Notes: * including industrial and domestic waste; If GHG emission from peat fires is not covered by LULUCF, Indonesia generate 1.078 Giga Ton CO2eq. * including emission from industries; SNC= Indonesian Second National Communication 2009; other data from World Bank (2007)
## GHG Emissions, Ton per year

<table>
<thead>
<tr>
<th>Sector</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>Growth, % per yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>247,522</td>
<td>280,938</td>
<td>306,774</td>
<td>327,911</td>
<td>333,950</td>
<td>372,123</td>
<td>5.7</td>
</tr>
<tr>
<td>Industry</td>
<td>40,342</td>
<td>42,814</td>
<td>49,810</td>
<td>43,716</td>
<td>46,118</td>
<td>47,971</td>
<td>2.6</td>
</tr>
<tr>
<td>Agriculture</td>
<td>2,178</td>
<td>42,814</td>
<td>49,810</td>
<td>43,716</td>
<td>46,118</td>
<td>47,971</td>
<td>2.6</td>
</tr>
<tr>
<td>LUCF</td>
<td>1,060,766</td>
<td>1,060,766</td>
<td>1,287,495</td>
<td>345,489</td>
<td>617,423</td>
<td>674,828*</td>
<td>Fluctuated</td>
</tr>
<tr>
<td>Peat Fire*</td>
<td>172,000</td>
<td>172,000</td>
<td>172,000</td>
<td>172,000</td>
<td>172,000</td>
<td>172,000</td>
<td>1.2</td>
</tr>
<tr>
<td>Waste</td>
<td>1,662</td>
<td>1,662</td>
<td>1,662</td>
<td>1,662</td>
<td>1,662</td>
<td>1,662</td>
<td>1.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,524,472</td>
<td>1,524,472</td>
<td>1,524,472</td>
<td>1,524,472</td>
<td>1,524,472</td>
<td>1,524,472</td>
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</tr>
</tbody>
</table>

## GHG Emissions, Ton CO2-eq per year

<table>
<thead>
<tr>
<th>Sector</th>
<th>2000</th>
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<tr>
<td>Energy</td>
<td>280,938</td>
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<td>333,950</td>
<td>372,123</td>
<td>369,800</td>
<td>5.7</td>
</tr>
<tr>
<td>Industry</td>
<td>42,814</td>
<td>49,810</td>
<td>43,716</td>
<td>46,118</td>
<td>47,971</td>
<td>48,733</td>
<td>2.6</td>
</tr>
<tr>
<td>Agriculture</td>
<td>75,420</td>
<td>77,501</td>
<td>77,030</td>
<td>79,829</td>
<td>77,863</td>
<td>80,179</td>
<td>1.1</td>
</tr>
<tr>
<td>Waste</td>
<td>157,328</td>
<td>160,818</td>
<td>162,800</td>
<td>164,074</td>
<td>165,799</td>
<td>166,831</td>
<td>1.2</td>
</tr>
<tr>
<td>LUCF</td>
<td>649,254</td>
<td>560,546</td>
<td>1,287,495</td>
<td>345,489</td>
<td>617,423</td>
<td>674,828*</td>
<td>Fluctuated</td>
</tr>
<tr>
<td>Peat Fire¹</td>
<td>172,000</td>
<td>194,000</td>
<td>678,000</td>
<td>246,000</td>
<td>440,000</td>
<td>451,000</td>
<td>Fluctuated</td>
</tr>
<tr>
<td>TOTAL (+LUCF)</td>
<td>1,377,753</td>
<td>1,349,449</td>
<td>2,576,952</td>
<td>1,215,460</td>
<td>1,721,179</td>
<td>1,991,371</td>
<td>Fluctuated</td>
</tr>
<tr>
<td>TOTAL w/o LUCF</td>
<td>556,499</td>
<td>594,903</td>
<td>611,457</td>
<td>623,971</td>
<td>663,756</td>
<td>665,544</td>
<td>3.2</td>
</tr>
</tbody>
</table>
Current Condition of Energy Sector in Indonesia

- Energy consumption grows 5.45 %/year (2000-2010), in which share of fossil fuels 90% (oil 51%) of supply mix and GHG increases 5%/year.
- Energy development is guided by ‘energy supply security’ concern → it is based on least cost and resources availability.
- Target share of different sources of energy in 2025:
  - oil < 20% (decreases from 54.78% in 2005)
  - natural gas ≈ 30% (increases from 22.2% in 2005)
  - coal > 33% (increased from 16.77% in 2005)
  - geothermal > 5% and other NRE > 5%
  - develop biofuel to achieve at least 5%
  - develop liquefied coal to achieve 2% (18 MMBOE) in 2020
- Shift of new-renewable from 4.5% (2005) to 25% (2025) is positive to climate change mitigations, however, coal increases from 14% (2003) to 33% (2025) will negatively affect climate change mitigations
- There is potential to reduce GHG by deployment of renewable energy.
- Indonesia relies on imported technology in all sectors, in which energy technologies are still inefficient, there are rooms for improvements.
## Energy Resource Potential of Indonesia

<table>
<thead>
<tr>
<th>Fossil Energy</th>
<th>Resources</th>
<th>Reserves (Proven + Possible)</th>
<th>Annual Production</th>
<th>R/P, year (*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>56.6 BBarrels</td>
<td>8.2 BBarrels (**)</td>
<td>357 MBarels</td>
<td>23</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>334.5 TCF</td>
<td>170 TCF</td>
<td>2.7 TSCF</td>
<td>63</td>
</tr>
<tr>
<td>Coal</td>
<td>104.8 Btons</td>
<td>18.8 Btons</td>
<td>229.2 Mtons</td>
<td>82</td>
</tr>
<tr>
<td>Coal Bed Methane</td>
<td>453 TCF</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

(*) assuming no new discovery; (**) including Cepu Block

<table>
<thead>
<tr>
<th>New and Renewable Energy</th>
<th>Resources</th>
<th>Installed Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>75.670 MW</td>
<td>4.200 MW</td>
</tr>
<tr>
<td>Geothermal</td>
<td>27.510 MW</td>
<td>1.052 MW</td>
</tr>
<tr>
<td>Mini/Micro Hydro</td>
<td>500 MW</td>
<td>86.1 MW</td>
</tr>
<tr>
<td>Biomass</td>
<td>49.810 MW</td>
<td>445 MW</td>
</tr>
<tr>
<td>Solar Energy</td>
<td>4,80 kWh/m²/day</td>
<td>12.1 MW</td>
</tr>
<tr>
<td>Wind Energy</td>
<td>9.290 MW</td>
<td>1.1 MW</td>
</tr>
<tr>
<td>Uranium (*** )</td>
<td>3 GW for 11 years* (e.q. 24,112 ton)</td>
<td>30 MW</td>
</tr>
</tbody>
</table>

(***) Only at Kalan – West Kalimantan

Source: Data and Information Center, MEMR, 2009
Methodology

- To create low carbon development scenario, a method based on ‘back casting approach’ has been developed with sets of desirable goal first and then seek the way to achieve it;
- Setting of framework: base year (2005) and target year (2010), environmental target, target area, and number of scenarios;
- Describing and quantifying of socio economic assumptions;
- Collecting and setting of low carbon measures;
- Estimating the GHG in the target year; and
- Confirming measures and policy recommendation.

There are 5 important steps:
- depicting socio economic visions toward 2050
- estimating current energy service, demand-supply, CO₂ emission
- exploring innovations for energy demand-supply;
- estimating energy demand/supply and CO2 emissions in two scenarios using ExSS–GAMS 23.3 and various technical, economic, social parameters;
- analyzing of domestic potential to achieve energy-related CO₂ reduction.
Development scenarios to 2050 with respect to LCDS

- Base year: 2005 and Projection 2050
- BaU (moderate scenario): current development trend and society orientation will continue until 2050, in which people lifestyles and activities do not have implication to the generation of CO$_2$ emissions.
- CM1 (moderate scenario): economic development will be the same as BAU but society is more efficient in energy utilizations (use technology with higher energy efficiency) compared to the BAU. The society is depicted as calmer, slower, and nature oriented. This scenario is regarded as moderate development path.
- CM2 (high scenario): the economy will grow at much higher rate compared to those of the BAU but more efficient and less carbon energy systems. It assumes that Indonesia is to reduce significant emission to comply with world’s LCD target (0.5 ton C/ capita) in 2050, where society is depicted as more active, quick changing, and technology oriented. This scenario is regarded as high development path.
Results and Discussions
Change in GDP structure toward tertiary industry

GDP (trillion rupiah)

- BAU and CM1
- CM2
- BAPENAS Projection

Gross output (trillion rupiah)

- Commercial
- Cement
- Iron and Stel
- Other Industries
- Construction
- Chemicals
- Textile, Wood, Paper
- Food and Beverage
- Mining and Quarrying
- Agriculture

GDP*/capita

- Million Rupiah

2000

Japan
Singapore
Brunei
Hong Kong
South Korea
Malaysia
China
BAU (2050)
CM1 (2050)
CM2 (2050)

* at constant price 2000

2050
Estimation results for base year (2005) and target year (2050)

<table>
<thead>
<tr>
<th>Energy Emission Parameter</th>
<th>2005 Base</th>
<th>2050 BaU</th>
<th>2050 CM1</th>
<th>2050 CM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Demand, kToe</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Transport</td>
<td>19,013</td>
<td>41,406</td>
<td>12,543</td>
<td>8,146</td>
</tr>
<tr>
<td>Freight Transport</td>
<td>6,562</td>
<td>126,510</td>
<td>45,623</td>
<td>42,056</td>
</tr>
<tr>
<td>Residential</td>
<td>42,832</td>
<td>69,761</td>
<td>38,710</td>
<td>59,018</td>
</tr>
<tr>
<td>Industry</td>
<td>30,015</td>
<td>569,325</td>
<td>471,039</td>
<td>543,266</td>
</tr>
<tr>
<td>Commercial</td>
<td>3,704</td>
<td>111,952</td>
<td>68,039</td>
<td>129,068</td>
</tr>
<tr>
<td>Total demand</td>
<td>102,126</td>
<td>918,953</td>
<td>635,954</td>
<td>781,555</td>
</tr>
<tr>
<td>Energy Demand per capita, toe/cap</td>
<td>0.47</td>
<td>2.81</td>
<td>1.95</td>
<td>2.71</td>
</tr>
<tr>
<td>Energy Intensity, Toe/Million Rp.</td>
<td>57.15</td>
<td>24.84</td>
<td>17.19</td>
<td>11.45</td>
</tr>
<tr>
<td>Emissions, million Ton C**</td>
<td>82.45</td>
<td>1,183.82</td>
<td>617.12</td>
<td>181.13</td>
</tr>
<tr>
<td>Emision, ton C / capita</td>
<td>0.38</td>
<td>3.62</td>
<td>1.89</td>
<td>0.63</td>
</tr>
<tr>
<td>Emissions, million Ton CO2</td>
<td>302.33</td>
<td>4,340.68</td>
<td>2,262.77</td>
<td>664.16</td>
</tr>
<tr>
<td>Emision per capita Ton CO2 / capita</td>
<td>1.38</td>
<td>13.28</td>
<td>6.92</td>
<td>2.31</td>
</tr>
<tr>
<td>GDP Growth</td>
<td>7%</td>
<td>7%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>Energy demand growth</td>
<td>5%</td>
<td>4%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Energy elasticity</td>
<td>0.77</td>
<td>0.62</td>
<td>0.62</td>
<td></td>
</tr>
</tbody>
</table>

Notes: BaU* refer to existing GDP structure, BaU refer to new GDP structure; energy demand in residential includes biomass
** excluding other GHG emissions (CH4, N20, etc), which in energy sector are relatively small
Emission/capita from energy [Source: AIM training WS Asian LCDS Study, 2010]

GHG emissions per capita

Developed Countries

Developing Countries

Indonesia (2005): 0.38 ton C/capita

Leapfrog-development

World Target (2050): 0.5 ton C/capita

Indonesia BAU (2050): 3.62 ton C/capita (13.28 ton CO2/capita)

High Energy Locked-in Type Development

With High Damage on Economy and Natural System

International (2005), Ton C/capita
- Japan, UK, Germany 2.5
- US 5.5; Canada 4.2
- India 0.3; China 0.6
- World (average) 1.0 – 1.1

Per Capita Emission (tC)

Energy All (Exc. LUCF) All (Inc. LUCF)

0.0 0.5 1.0 1.5 2.0 2.5

Indonesia BAU (2050): 3.62 ton C/capita (13.28 ton CO2/capita)

GHG per capita in 2050
CM1 0.89 ton C (6.91 ton CO2)
CM2 0.63 ton C (2.31 ton CO2)

CO2 EMISSIONS REDUCTION CHALLENGE OF DEVELOPING COUNTRIES

Emission/capita from energy [Source: AIM training WS Asian LCDS Study, 2010]
Socio-economy, energy, and CO2 for each development scenario

CO₂ emissions by sector, million ton C
MITIGATION STRATEGIES

To achieve the above scenarios, Indonesian development in energy sector should implement several actions, which can be grouped into:

• **Clean Energy**: renewable/less carbon emitting energy and technology in residential/commercial;

• **Low Carbon Lifestyle**: efficiency improvement through appliances technology and society behavior in residential/commercial;

• **Low Carbon Electricity**: more renewable energy, efficient power generation (pulverized to sub-critical, supercritical, and integrated gasification combined cycle (IGCC) equipped with carbon capture and storage (CCS), and decreasing losses in T&D of electricity grids;

• **Low Carbon Fuels Industry**: energy shift (toward renewable and less carbon emitting fuels), efficiency improvement of industrial processes, equipment, and appliances;

• **Sustainable transport**: transport mode shift (more mass rapid transport), fuel shift (to renewable/less carbon emitting fuels), reducing trip generation & trip distance (improvement infrastructure, telecommunication, information access), traffic management, efficiency improvement.
Drivers of GHG Emissions can be identified from “IPAT identity”:

\[ \text{Impact} = \text{Population} \times \text{Affluence} \times \text{Technology} \]

\[ \text{CO}_2 \text{ Emissions} = \text{Population} \times (\text{GDP/Population}) \times (\text{Energy/GDP}) \times (\text{CO}_2 /\text{Energy}) \]

(“Kaya” multiplicative identity)

\[ \text{Net} \ C = P\left(\frac{\text{GDP}}{P}\right)\left(\frac{E}{\text{GDP}}\right)\left(\frac{C}{E}\right) - S \]

\[ \downarrow \quad \downarrow \]

Energy Efficient \quad Clean Energy and Technology

Climate Change Mitigation Actions are to reduce Nett GHG Emisions
LCS Actions

Clean Energy (Residential and Commercial)
- Renewable energy or Less CO2 Emission Energy
- Less CO2 Emission Energy Technology
- Society Behavior in Residential /Commercial
- Efficient energy technology appliances

Low Carbon Style (Residential and Commercial)

Low Carbon Electricity
- Renewable energy & Less CO2 Emission Energy
- Efficient energy technology of power generation
- Less CO2 Emission Energy Technology (Coal IGCC + CCS)
- Increasing Efficiency of T & D

Low carbon energy system in industry
- Renewable energy or Less CO2 Emission Energy
- Efficient energy technology appliances
- Efficient energy process and processing technology

Sustainable transport
- Renewable energy or Less CO2 Emission Energy
- modal shift (public/mass rapid transport utilization)
- Energy Efficiency Improvement
- Reduce trip generation and distance (improve infrastructure, telecommunication, new urban design, traffic management)
Action 1 Clean Energy: Increase share of renewable/less carbon emitting fuels
Action 2 Low Carbon Lifestyle:

Final energy demand by service (left) and by fuel (right) in residential sector

Final energy demand by service (left) and by fuel (right) in commercial sector
Action3: Low Carbon Electricity

Energy efficiency level of power generation in each scenario

Share of power supply by energy type in each scenario

Fuel consumption and CO₂ emission of power generation sector in each scenario
Action 4: Low Carbon Energy Supply

Fuel consumption and CO$_2$ emission of power generation sector in each scenario
Action 5: Sustainable Transport

Transport demand by transport mode in (a) passenger transport & (b) freight transport

Effect of passenger and freight transport demand to energy demand and CO₂ emissions
Conclusion

- Indonesia has the potential to achieve LCD in 2050.

- CO₂ emissions reduction could be achieved through CM1 (economic development is as in BAU but society is more efficient in energy uses), the CO₂ is 1.89 ton C/capita in 2050, lower than BAU level (3.62 ton C/capita).

- The largest CO₂ emissions reduction down to 0.63 ton C/capita in 2050 (close to the world’s target of 0.5 ton C/capita in 2050) only could be achieved through CM2 (economy will grow at much higher rate than that of BAU but more efficient & less carbon energy systems).

- Realization of CM2 will require high economic growth with large investment for the deployment of clean and less emitting energy systems (new-renewable energy, efficient energy technology, sustainable transport, changing in demand behavior).

- Further researches are needed to study and formulate strategy, policy, and development paths related to CM2 scenario. It also cover how to achieve high economic growth while maintaining low CO₂ in all related sectors.
THANK YOU

Indonesia Low Carbon Society Vision of 2050 In Energy Sector
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