Pilot testing of GBEP Sustainability Indicators in Indonesia

Project updates & lessons learnt

Activity Group 2

“Raising awareness and sharing of data and experiences from the implementation of the GBEP indicators”
IRENA Offices in Bonn, Germany, July 3-4, 2014

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Project Lead Technical Adviser
Food and Agriculture Organization of the United Nations
PILOT TESTING OF GBEP SIB IN INDONESIA

Presentation’s content:

• Project overview
  • Goals of the project
  • Country Actors

• Status update
  • Challenges & possible solutions
  • Indicators we are completing
  • Indicator 8 – Measurement updates

• Lessons learnt & Recommendations
PILOT TESTING THE INDICATORS

Goals of the project:

• Assess and enhance the capacity of the country to measure the GBEP Indicators and use them to inform policy making; and

• Learn lessons about how to apply the indicators as a tool for sustainable development and how to enhance the practicality of the tool
Country actors

- Ministry of Energy and Mineral Resources
  - Dadan Kusdiana, Director of Bioenergy, Directorate General of New and Renewable Energy and Energy Conservation

- Consultants at Bogor Agricultural University (IPB) have a team comprising 18 members.

- LUC and peatland experts from Indonesian Soil Research Institute:
  - Dr. Fahmuddin Agus
Indonesia is a **vast** and **complex** country;

The analysis performed during the first phase of the project:

- Geographical coverage *not at the national level*
- Representativeness of some indicators *is not optimal*
- Multiple bioenergy forms *have different weight in the bioenergy portfolio* and project constraints have to be considered
COUNTERMEASURES

1) Geographical coverage not at the national level

• Enhanced use of remote sensing techniques and information for selected indicators

• Enhanced use of GIS tools for the elaboration of the information and graphic representation of the results
2) Representativeness less-than optimal

In addition to increased geographical coverage:

- Enhance *spectrum of stakeholders* = *provide further access to information*

- Enhance *participatory approach* to the assessment of indicator values = *chance to discuss all aspects of the measurement, cross cutting issues, discover implications, etc.*
COUNTERMEASURES

3) Multiple bioenergy forms have different weight in the bioenergy portfolio

- Focus on main modern bioenergy type at present (ex-post)

Palm Oil Biodiesel represents the major current modern bioenergy type produced and employed in Indonesia

  - Since 2010, fuel ethanol production has been discontinued
  
  - Modern solid & gaseous biomass applications at the operator level
WHAT INDICATORS?

Indicator 1 – *Lifecycle assessment of GHG*:

- Include GHG emission from LUC
- Revise calculations
- Assess presence of CH$_4$ capture systems
- Capacity development – Intl. experts’ support
  - Training: 2 sessions in the country
Indicator 2 – *Soil quality*:

- Include considerations on SOC
- If possible, include *changes* in SOC
- **Maps of soil type & feedstock cultivation**
- Maps of soil quality parameters (erosion, salinization, subsidence, etc)
WHAT INDICATORS?

Indicator 3 – *Harvest levels of wood resources:*

- Include disaggregated values of *sustained yield/net annual growth*

- Include statistics on woodfuel production and use
Indicator 5 – Water use and efficiency:

- Include data on water requirement based on annual evapotranspiration
- Couple watershed level TARWR with OP cultivation surfaces in the watershed
- Include timeseries for TAWW
WHAT INDICATORS?

Indicator 7 – *Biodiversity in the Landscape:*

- Conduct research on **status of HCV areas and** national recognition of HCV areas and OP plantation development overtime

- Conduct research on **invasive species associated with feedstock production**

- Incidence of biodiversity **conservation practices**
WHAT INDICATORS?

Indicator 8 – *Land Use and Land Use Change*:

- Include maps of LUC due to OP in Indonesia from 1990 to 2010 (and related GHG emissions)
- Estimate share attributable to bioenergy production;
- Based on BD refineries location, estimate possible pertinence plantations
WHAT INDICATORS?

Indicator 23 – *Infrastructure and logistics*:

- Inclusion of maps of transportation system and infrastructures.

- Determine the capacity (ton/year, etc) of each of the distribution systems identified. --> Calculate/estimate how much biodiesel/biodiesel feedstock is moved on each road, port, etc.

- Learn about the status of these infrastructures is relevant for other indicators as well.
Indicator 8 – Land Use and Land Use Change

**Indicator 8 Land use and land-use change related to bioenergy feedstock production**

*Description:*

(8.1) Total area of land for bioenergy feedstock production, and as compared to total national surface and (8.2) agricultural land and managed forest area

(8.3) Percentages of bioenergy from:

- (8.3a) yield increases,
- (8.3b) residues,
- (8.3c) wastes,
- (8.3d) degraded or contaminated land

(8.4) Net annual rates of conversion between land-use types caused directly by bioenergy feedstock production, including the following (amongst others):

- arable land and permanent crops, permanent meadows and pastures, and managed forests
- natural forests and grasslands (including savannah, excluding natural permanent meadows and pastures), peatlands, and wetlands

*Measurement unit(s):*

(8.1-2) hectares and percentages
(8.3) percentages
(8.4) hectares per year
8.1 – Total area of land for bioenergy feedstock production as compared to total national surface:

Total national surface in 2012 was **181.9 million ha** (adjusted from Landsat Imagery and FAO as per Gunarso et al, 2013)

Total Crude Palm Oil produced in 2012 was **26.5 million tonnes** (Ministry of Agriculture)

Total agricultural land in 2011 was **54.5 million ha** (FAOSTAT)

Total forest area in 2011 was **93 million ha** (Ministry of Forestry)

Total surface cultivated with oil palm was **9.2 million ha** (Landsat Imagery, Ministry of Agriculture)

Total Biodiesel produced domestically from CPO was **1.8 million tonnes** (Pertamina, 2012)

Total area of land attributable to production of bioenergy feedstock: **7.54 % of total area for CPO** (based on BD output), ~ **690.000 ha**

Total area of land attributable to production of bioenergy feedstock as compared to total national surface: **0.38%**

8.2 – Total area of land for bioenergy feedstock production as compared to total agricultural and forest area:

Total area of land attributable to production of bioenergy feedstock as compared to agricultural land: **1.26%**

Total area of land attributable to production of bioenergy feedstock as compared to forest area: **0.74%**
Indicator 8

8.3 – Percentages of bioenergy (biodiesel) from:
8.3a – yield increase
8.3b – residues
8.3c – wastes
8.3d – degraded or contaminated land

FFB yields in Indonesia between 1990 and 2012 in ton/ha

FFB yields overall stable; from 2005 slightly declining

Source: FAOSTAT, 2013
INDICATOR 8.4 - Net annual rates of conversion between land use types caused directly by bioenergy feedstock production
Methodology:

- Maps of Sumatera, Kalimantan, Papua
- Scale: 1:250,000
- Landsat imagery (for cover types)
- Survey maps (soil types)
- Indonesian Soil Research Institute: GIS expert + LUC and GHG expert
LUC to OP (1990 – 2010)
Enhanced representativeness

In 2010 in Indonesia about **8.5 million hectares** were planted with oil palm.

In 2010 in Sumatera + Kalimantan + Papua about **7.7 million ha** of land planted with OP.

**Consistently**, from 2000 to 2010, **S+K+P** have **90.5%** of total planted area.

**High representativeness of the study**
LUC to OP land cover categories

- **Forests**
  - Undisturbed Forest
  - Disturbed Forest
  - Undisturbed Swamp Forest
  - Undisturbed Mangrove
  - Disturbed Swamp Forest
  - Disturbed Mangrove
  - Rubber Plantation
  - Oil Palm Plantation
  - Timber Plantation
  - Mixed Tree Crops
  - Shrubs
  - Swamp Shrubs
  - Dry Cultivation
  - Settlement
  - Grass
  - Swamp Grass
  - Rice Field
  - Coastal Fish Pond
  - Bare Land
  - Mining
  - Water Body
  - No data (cloud)

- **Plantations (perennial crops)**

- **Annual crops**

- **Shrubs**

- **Others**

- **Mineral soils**

- **Peat soils**

**Legend**
- Green: Forests to Oil Palm Plantation
- White: Oil Palm Plantation to Oil Palm Plantation
- Blue: Shrubs to Oil Palm Plantation
- Purple: Dry Cultivation
- Yellow: Annual Crops to Oil Palm Plantation
- Red: Other Plantations to Oil Palm Plantation
- Brown: Others to Oil Palm Plantation

**Soils**
- Mineral Soils
- Peat Soils

**Source:** Global Bioenergy Partnership
Sumatera LUC to OP map 2000 - 2005
Sumatera LUC to OP map 1990 - 2010
<table>
<thead>
<tr>
<th></th>
<th>Peat Sumatra</th>
<th>Peat Kalimantan</th>
<th>Peat Papua</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial land use</td>
<td>Forests 233,700 41,152 88,194 350,836</td>
<td>12,049 2,166 149,284 163,499 0 192 206 398</td>
<td>0 0 0 0 1,280 0 0 1,280</td>
</tr>
<tr>
<td></td>
<td>Shrub 7,960 14,115 122,140 144,214</td>
<td>3,714 7,307 68,945 81,242 0 0 0 242 0 0 0 242</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oilpalm 221,116 597,854 876,498 221,116</td>
<td>500 18,010 28,697 500 0 0 0 1,280 0 0 0 1,280</td>
<td></td>
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<tr>
<td>Other plantations</td>
<td>135,057 215,401 123,144 473,602</td>
<td>167 46 1,391 1,604 0 1,088 0 1,088</td>
<td></td>
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<tr>
<td></td>
<td>Annual crops 21 7,603 3,422 244,726</td>
<td>1,473 0 5,360 6,833 0 0 0 0 0 0 0 0</td>
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<tr>
<td></td>
<td>Others 0 0 3,091 3,091</td>
<td>0 0 0 0 0 0 0 0</td>
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</tr>
<tr>
<td></td>
<td>Sum 597,854 876,498 1,216,489 1,216,489</td>
<td>17,901 27,529 253,677 253,677 0 1,280 1,728 1,728</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate of conversion (ha/yr)</th>
<th>37,674</th>
<th>55,729</th>
<th>67,998</th>
<th>49,769</th>
<th>1,740</th>
<th>1,904</th>
<th>44,996</th>
<th>12,659</th>
<th>-</th>
<th>256</th>
<th>90</th>
<th>86</th>
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</thead>
<tbody>
<tr>
<td>Oil palm</td>
<td>221,116</td>
<td>597,854</td>
<td>876,498</td>
<td>1,216,489</td>
<td>500</td>
<td>17,901</td>
<td>27,529</td>
<td>253,677</td>
<td>0</td>
<td>0</td>
<td>1,280</td>
<td>1,728</td>
</tr>
<tr>
<td>Net change</td>
<td>376,737</td>
<td>278,644</td>
<td>339,991</td>
<td>995,373</td>
<td>17,402</td>
<td>9,518</td>
<td>224,980</td>
<td>251,900</td>
<td>0</td>
<td>1,280</td>
<td>448</td>
<td>1,728</td>
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</table>

<table>
<thead>
<tr>
<th>Initial land use</th>
<th>Forests</th>
<th>Shrub</th>
<th>Oilpalm</th>
<th>Other plantations</th>
<th>Annual crops</th>
<th>Others</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral Sumatra</td>
<td>440,279</td>
<td>24,615</td>
<td>54,792</td>
<td>309,736</td>
<td>101,459</td>
<td>0</td>
<td>500</td>
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<tr>
<td>Mineral Kalimantan</td>
<td>319,266</td>
<td>97,901</td>
<td>645,942</td>
<td>1,259,049</td>
<td>1,063,109</td>
<td>0</td>
<td>253,677</td>
</tr>
<tr>
<td>Mineral Papua</td>
<td>17,315</td>
<td>4,774</td>
<td>11,438</td>
<td>33,527</td>
<td>1,287</td>
<td>762</td>
<td>206</td>
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</table>

<table>
<thead>
<tr>
<th>Rate of conversion (ha/yr)</th>
<th>129,063</th>
<th>162,567</th>
<th>82,847</th>
<th>125,885</th>
<th>63,369</th>
<th>69,261</th>
<th>315,157</th>
<th>127,902</th>
<th>1,882</th>
<th>4,014</th>
<th>2,853</th>
<th>2,658</th>
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</thead>
<tbody>
<tr>
<td>Oil palm</td>
<td>997,838</td>
<td>2,288,468</td>
<td>3,101,303</td>
<td>3,515,539</td>
<td>85,242</td>
<td>719,307</td>
<td>1,067,270</td>
<td>85,242</td>
<td>17,315</td>
<td>4,774</td>
<td>11,438</td>
<td>33,527</td>
</tr>
<tr>
<td>Net change to OP</td>
<td>1,290,630</td>
<td>812,835</td>
<td>414,236</td>
<td>2,517,701</td>
<td>633,695</td>
<td>346,305</td>
<td>1,575,784</td>
<td>2,555,784</td>
<td>18,820</td>
<td>20,072</td>
<td>14,265</td>
<td>53,158</td>
</tr>
<tr>
<td>Oil palm</td>
<td>221,116</td>
<td>597,854</td>
<td>876,498</td>
<td>1,216,489</td>
<td>500</td>
<td>17,901</td>
<td>27,529</td>
<td>253,677</td>
<td>0</td>
<td>0</td>
<td>1,280</td>
<td>1,728</td>
</tr>
<tr>
<td>Peatland</td>
<td>18,820</td>
<td>28,745</td>
<td>18,820</td>
<td>28,745</td>
<td>27,529</td>
<td>27,529</td>
<td>13,789</td>
<td>13,789</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mineral soil</td>
<td>4,014</td>
<td>68,945</td>
<td>68,945</td>
<td>68,945</td>
<td>28,697</td>
<td>28,697</td>
<td>149,280</td>
<td>149,280</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

| Net change, total | 1,667,367 | 1,091,479 | 754,227 | 3,513,074 | 651,097 | 355,824 | 1,800,764 | 2,807,684 | 18,820 | 21,352 | 14,713 | 54,886 |
In 2010 on S+K+P there were 6.2 Mha of oil palm on mineral soils and 1.4 Mha on peat soils.
Historically, Sumatera has been the island where the majority of LUC to OP has taken place. LUC to OP on peat mostly in Sumatera. After 2005 in Kalimantan, a considerable OP expansion has taken place.
## Summary LUC to OP (1990 – 2010)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Forests</td>
<td>1,022,609</td>
<td>171,173</td>
<td>949,857</td>
</tr>
<tr>
<td>Shrubs</td>
<td>435,378</td>
<td>264,308</td>
<td>1,093,320</td>
</tr>
<tr>
<td>Oilpalm (beginning year)</td>
<td>1,333,442</td>
<td>3,671,204</td>
<td>5,139,859</td>
</tr>
<tr>
<td>Other plantations</td>
<td>822,112</td>
<td>972,133</td>
<td>375,520</td>
</tr>
<tr>
<td>Annual crops</td>
<td>16,931</td>
<td>45,764</td>
<td>138,389</td>
</tr>
<tr>
<td>Others</td>
<td>40,253</td>
<td>15,277</td>
<td>12,619</td>
</tr>
<tr>
<td>Total OP (end year)</td>
<td>3,671,204</td>
<td>5,139,859</td>
<td>7,712,390</td>
</tr>
<tr>
<td>Conversion rate (ha/year)</td>
<td>233,728</td>
<td>293,731</td>
<td>513,941</td>
</tr>
</tbody>
</table>
INDICATOR 8.4 - Net annual rates of conversion between land use types caused **directly** by bioenergy feedstock production

### Attribution of LUC to bioenergy feedstock

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Forests</td>
<td>0</td>
<td>0</td>
<td>71,619</td>
</tr>
<tr>
<td>Shrubs</td>
<td>0</td>
<td>0</td>
<td>82,436</td>
</tr>
<tr>
<td>Other plantations</td>
<td>0</td>
<td>0</td>
<td>28,314</td>
</tr>
<tr>
<td>Annual crops</td>
<td>0</td>
<td>0</td>
<td>10,435</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>0</td>
<td>951</td>
</tr>
<tr>
<td><strong>Rate of conversion (ha/year)</strong></td>
<td><strong>N/A</strong></td>
<td><strong>N/A</strong></td>
<td><strong>38,751</strong></td>
</tr>
</tbody>
</table>

Attribution is difficult, still under debate
Annual emission (tonnes of CO$_2$e) from peat decomposition, above-ground biomass on both peat and mineral soils attributable *directly* to bioenergy feedstock production

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Peat decomposition</td>
<td>0</td>
<td>0</td>
<td>4,033,027</td>
</tr>
<tr>
<td>AG Peatland</td>
<td>0</td>
<td>0</td>
<td>1,441,766</td>
</tr>
<tr>
<td>AG Mineral land</td>
<td>0</td>
<td>0</td>
<td>4,455,454</td>
</tr>
<tr>
<td>Total</td>
<td>N/A</td>
<td>N/A</td>
<td>9,930,247</td>
</tr>
</tbody>
</table>
Lessons learnt & Recommendations

• The **GBEP SIB are suitable** for the Indonesian context;

• They provide a useful structure for organizing research and debate;

• Methodological approach for some indicators needs revision and needs to offer **further guidance** for indicator’s measurement;
Lessons learnt & Recommendations (cont’d)

• **For the effective** measurement of the GBEP SIB In Indonesia (and similar country context) the use of **remote sensing** techniques and GIS tools is required;

• Local stakeholders, particularly technical staff, should be involved **since project inception** (data availability, capacity assessment, etc);

• **Consistency is key**: A) stakeholders representation (e.g. government, academia, private); B) stakeholders participation;
Lessons learnt & Recommendations (cont’d)

- Primary data collection, verification and editing is **time and resource intensive**, yet **necessary** for specific indicators;

- The **support of the GBEP SIB community of practice** to knowledge exchange and **capacity development** concerning selected indicators is also needed (e.g. training, workshops, etc);

- Measuring all 24 indicators is an exercise which maximizes benefits for policy **in many country contexts** (cross cutting issues e.g. Ind. 10, 23, etc);
Thank you

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E-mail: Marco.Colangeli@fao.org  
www.globalbioenergy.org
Further details on GHG emissions from LUC due to Indonesian OP
Annual peat decomposition emissions from oil palm plantations by initial land uses using IPCC (2013) emission factors.
GHG emission from LUC

Annual peat decomposition emissions from oil palm plantations by initial land uses using Agus et. al (2013) emission factors – including root respiration.
GHG emission from LUC

Above ground C stock of different land uses (Agus et al. 2014)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Initial land use</th>
<th>AG C-Stock Mg C/ha</th>
<th>Emission factor Mg CO$_2$/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>UDF</td>
<td>Undisturbed Forest</td>
<td>195</td>
<td>569</td>
</tr>
<tr>
<td>DIF</td>
<td>Disturbed Forest</td>
<td>169</td>
<td>473</td>
</tr>
<tr>
<td>USF</td>
<td>Undisturbed Swamp Forest</td>
<td>196</td>
<td>573</td>
</tr>
<tr>
<td>UDM</td>
<td>Undisturbed Mangrove</td>
<td>170</td>
<td>477</td>
</tr>
<tr>
<td>DSF</td>
<td>Disturbed Swamp Forest</td>
<td>155</td>
<td>422</td>
</tr>
<tr>
<td>DIM</td>
<td>Disturbed Mangrove</td>
<td>120</td>
<td>294</td>
</tr>
<tr>
<td>CPL</td>
<td>Rubber Plantation</td>
<td>63</td>
<td>84</td>
</tr>
<tr>
<td>OPL</td>
<td>Oil Palm Plantation</td>
<td>40</td>
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<tr>
<td>TPL</td>
<td>Timber Plantation</td>
<td>64</td>
<td>88</td>
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<tr>
<td>MTC</td>
<td>Mixed Tree Crops</td>
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<td>-37</td>
</tr>
<tr>
<td>SCH</td>
<td>Schrubs</td>
<td>30</td>
<td>-37</td>
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<td>SSH</td>
<td>Swamp Shrubs</td>
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<td>DCL</td>
<td>Dry Cultivation</td>
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<td>CFP</td>
<td>Coastal Fish Pond</td>
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<td>BRL</td>
<td>Bare Land</td>
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<td>MIN</td>
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<td>WAB</td>
<td>Water Body</td>
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<tr>
<td>NCL</td>
<td>No data (cloud)</td>
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<td>-147</td>
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</table>
Above-ground biomass **annual emissions** due to land use change on **peat soils** in Sumatra, Kalimantan and Papua.
Above-ground biomass annual emissions due to land use change on mineral soils in Sumatra, Kalimantan and Papua.
GHG emission from LUC

Above ground and peat decomposition CO₂ emissions from oil palm plantation in Sumatra, Kalimantan and Papua

CO₂ emissions (million Mg yr⁻¹)

- AG Mineral land
- AG Peatland
- Peat decomposition

Period:
- 1990-2000
- 2000-2005
- 2005-2010
GHG emission from LUC

Above ground and peat decomposition CO₂ emissions from oil palm plantation in Sumatra, Kalimantan and Papua

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Peat decomposition</td>
<td>22,779,184</td>
<td>36,454,995</td>
<td>53,488,418</td>
</tr>
<tr>
<td>AG Peatland</td>
<td>11,364,167</td>
<td>6,737,305</td>
<td>19,121,570</td>
</tr>
<tr>
<td>AG Mineral land</td>
<td>38,622,293</td>
<td>16,582,024</td>
<td>59,090,903</td>
</tr>
<tr>
<td>Total</td>
<td>72,765,644</td>
<td>59,774,323</td>
<td>131,700,891</td>
</tr>
</tbody>
</table>
**GHG emission from LUC**

Annual emission (tonnes of CO$_{2}$e) from peat decomposition, above-ground biomass on both peat and mineral soils attributable *directly* to bioenergy feedstock production

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Peat decomposition</td>
<td>0</td>
<td>0</td>
<td>4,033,027</td>
</tr>
<tr>
<td>AG Peatland</td>
<td>0</td>
<td>0</td>
<td>1,441,766</td>
</tr>
<tr>
<td>AG Mineral land</td>
<td>0</td>
<td>0</td>
<td>4,455,454</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>N/A</strong></td>
<td><strong>N/A</strong></td>
<td><strong>9,930,247</strong></td>
</tr>
</tbody>
</table>