Life cycle evaluation of palm oil biodiesel in Thailand

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JGSEE

Joint Graduate School of Energy and Environment

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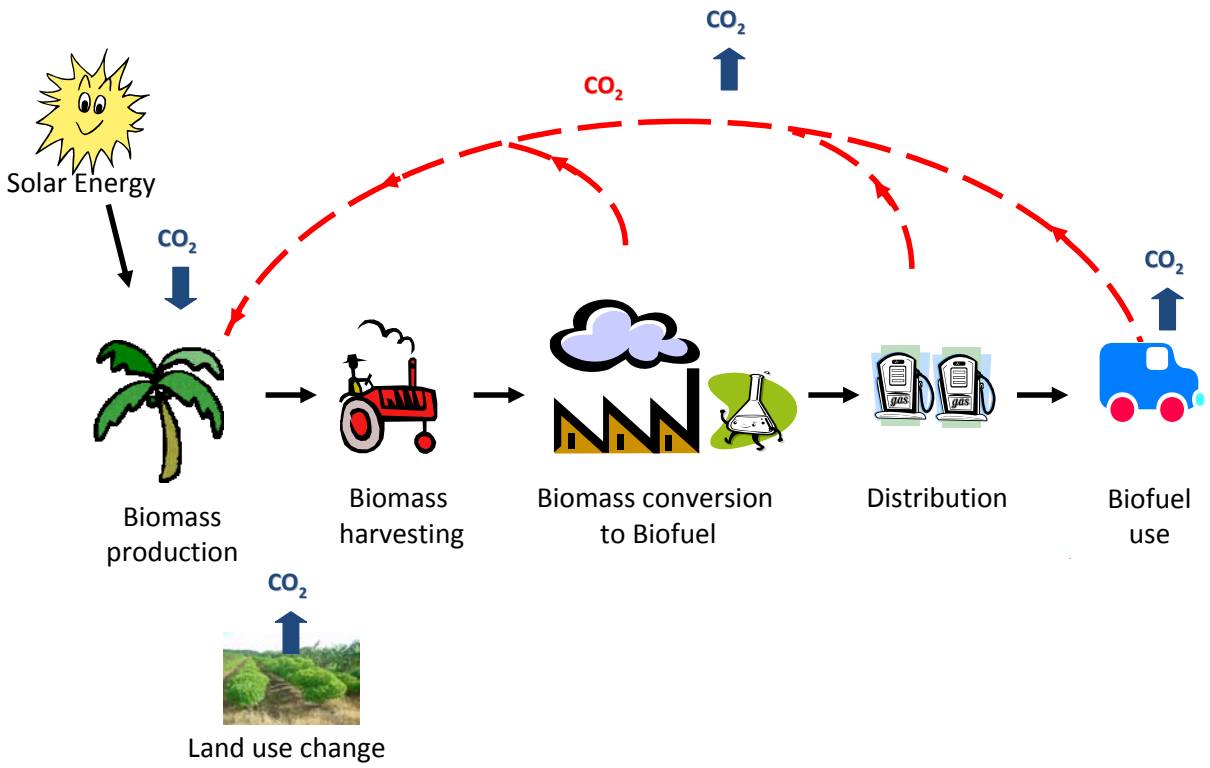
- Center of Excellence in Energy Technology and Environment established in 1998
- Research-based and Professional-oriented graduate programs in Energy and Environmental Technology & Management
- Strategic Environmental Assessment (SEA) Group's research areas:
  - ❖ LCA of biofuels
  - ❖ LCA of power production
  - ❖ Ecolabelling and Certification
  - ❖ Sustainable development indicators

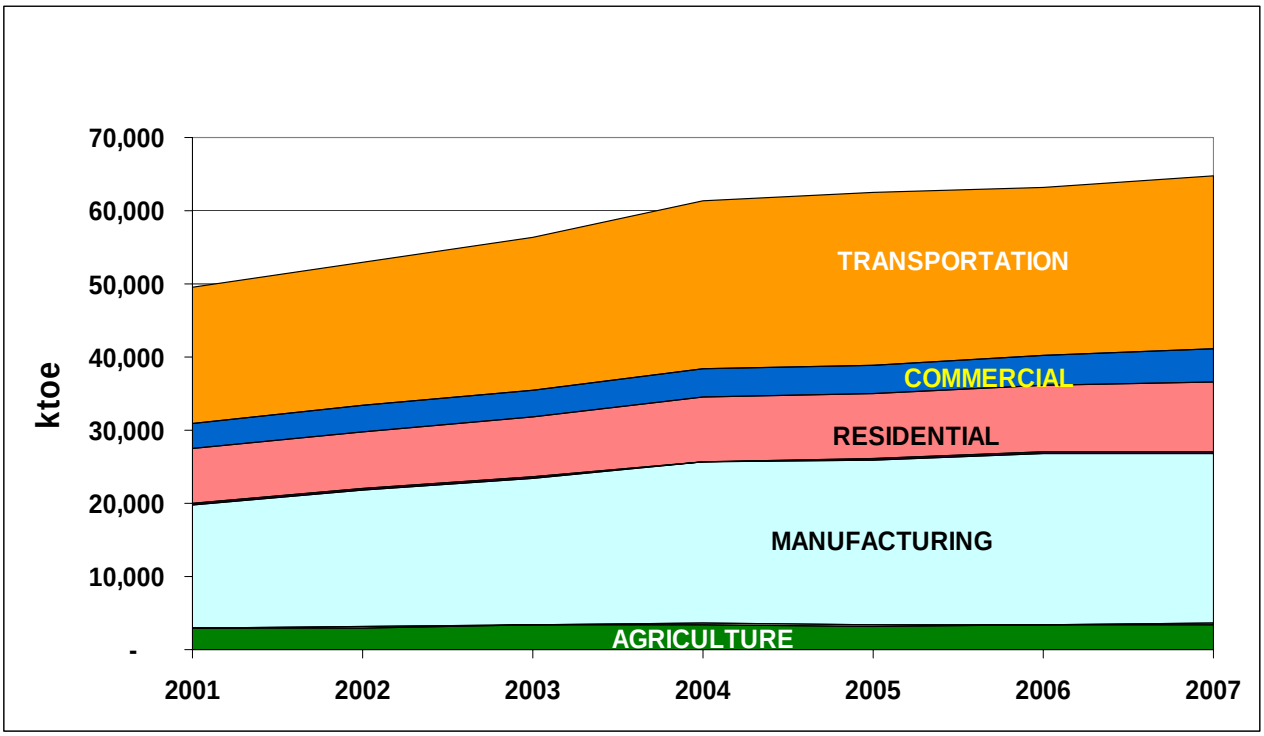
Why are biofuels considered green?



Expanding system boundaries of biofuels

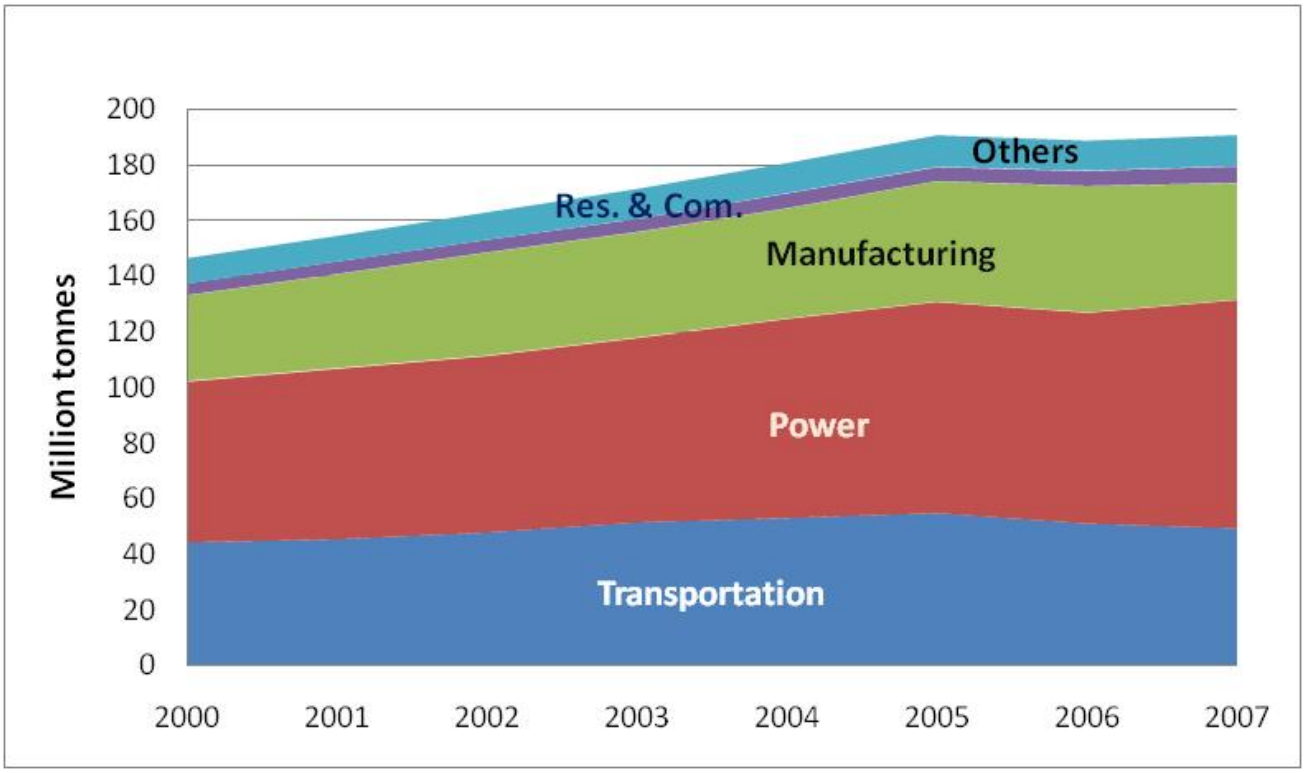
- only use phase – carbon neutral
- from the cultivation to end use – carbon benefits achievable
- expand the boundary further to include land use change effects – carbon benefits questionable
  - sugarcane cultivation on grassland – net benefits feasible
- ripple effects throughout the whole world
  - how does reduced soybean production in the US affect palm oil prices (and probably impacts too) in Thailand?
  - what if biofuel production results in displaced food production at another location where forests are cleared?
  - should these be part of the "environmental baggage" of the biofuel?

Final energy consumption by sector in Thailand



Source: Thailand Energy Situation, DEDE (2004-2007)

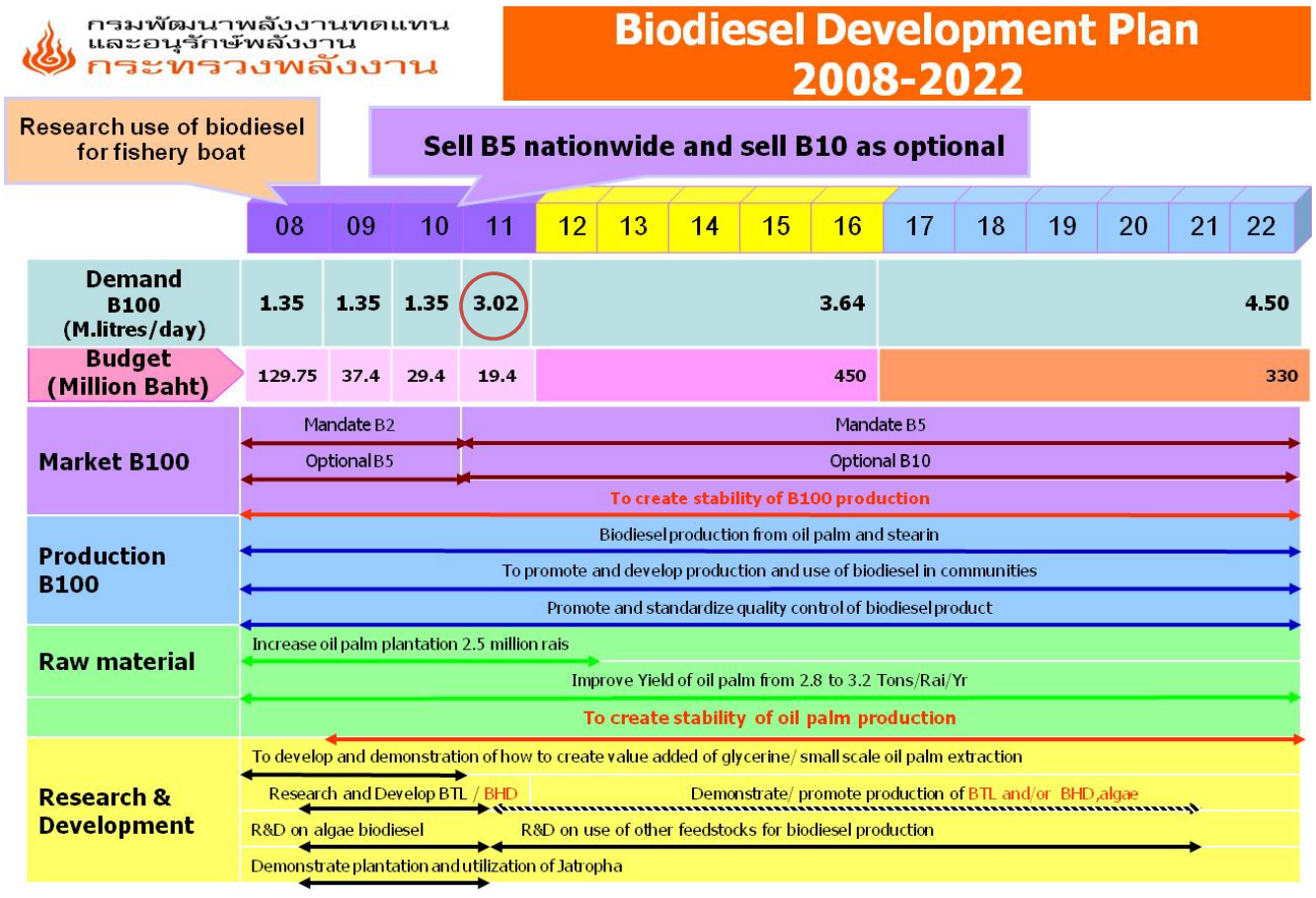
Estimated CO_2 emissions by sector in Thailand



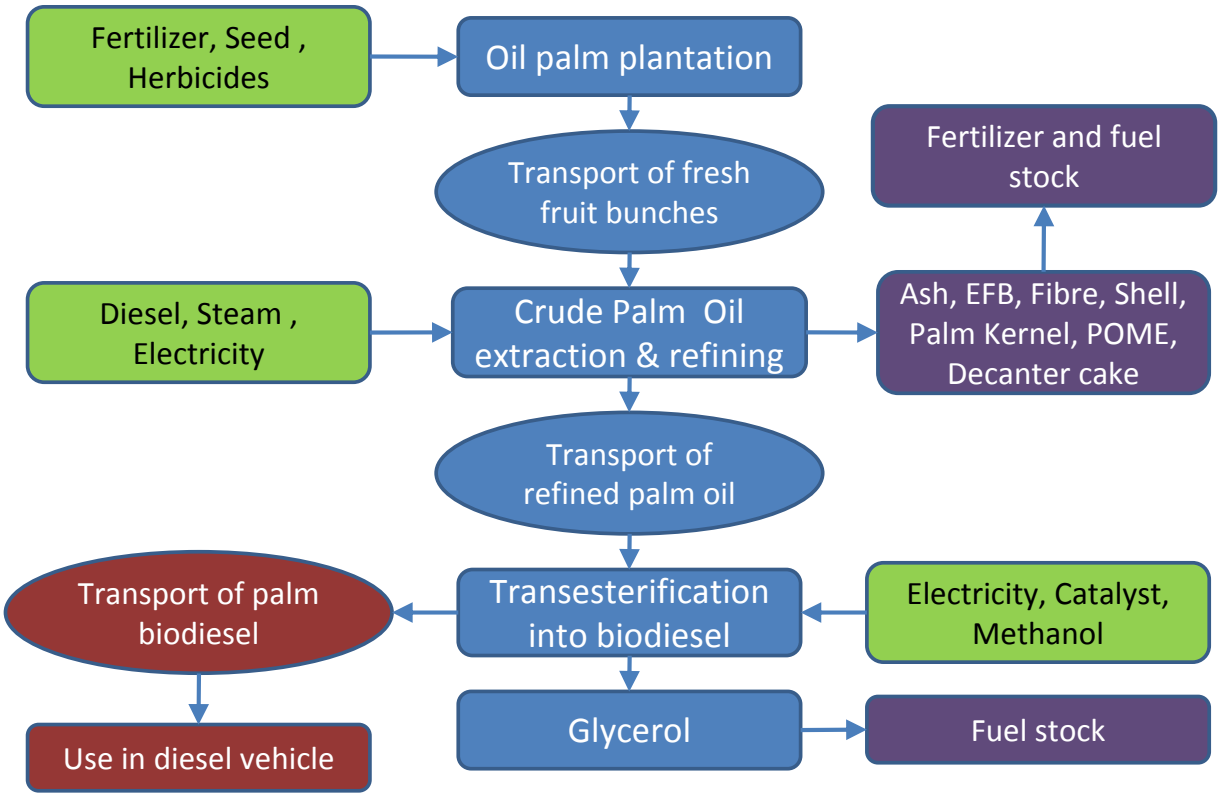
Source: Thailand Energy Situation, DEDE (2004-2007)

Expected benefits of biofuels

- Use of biofuels as an alternative transportation fuel
  - utilize local feedstocks – reduce imports
  - provide energy security
  - ensure steady income for farmers in rural areas
  - improve air quality?
  - help to reduce GHG emissions
- Several alternative feedstocks
  - Biodiesel: oil palm, jatropha, waste cooking oil, coconut
  - Bioethanol: cassava, molasses, sugar cane juice

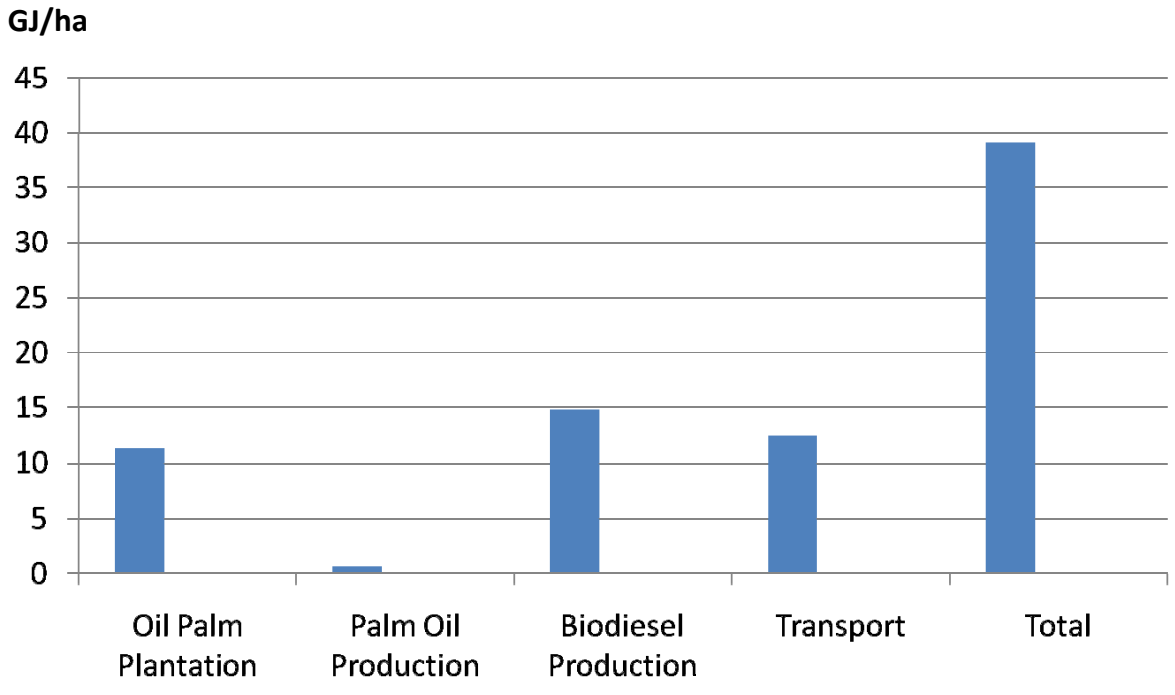


Life cycle diagram of palm biodiesel



Pleanjai and Gheewala (2009), Applied Energy, 86, Supplement 1, S209-S214

Energy inputs to palm biodiesel lifecycle



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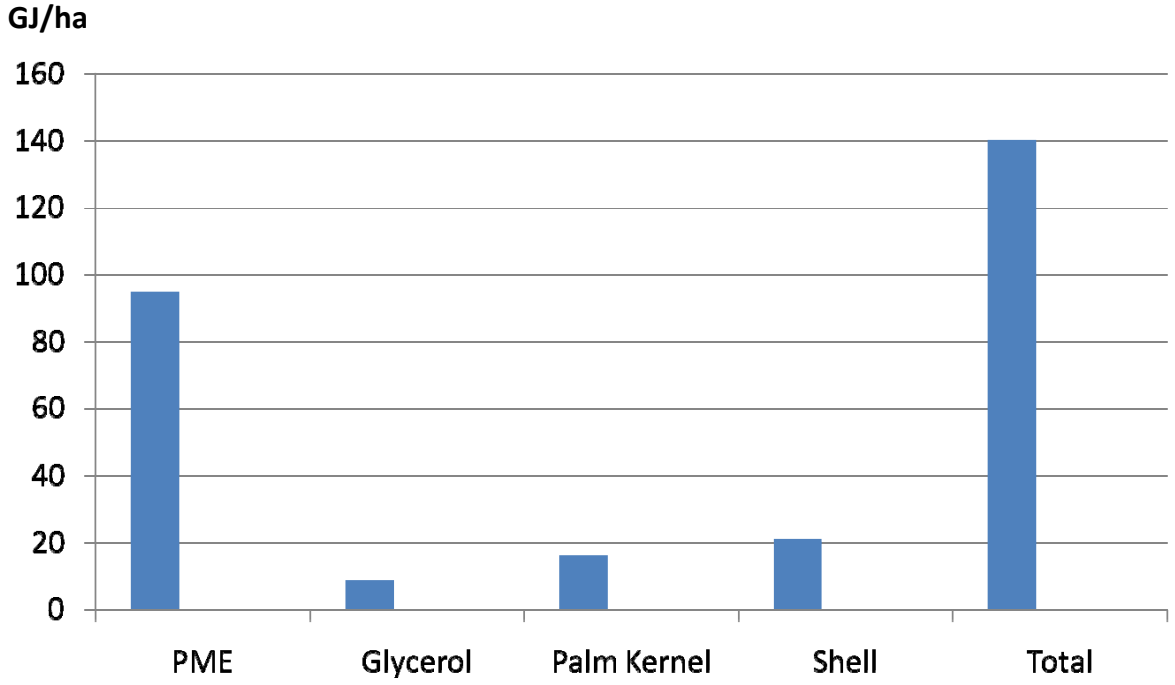
Energy outputs from palm biodiesel lifecycle



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Net Energy Ratio (NER)

- The largest energy inputs are from methanol production (35%) and fertilizer production (15%)
- Energy inputs for transportation are high but difficult to reduce as oil palm is mainly produced in the south of Thailand but is transported to the centre
- Palm oil production has a very low energy input as fibres are utilized for energy
- NER of palm biodiesel (without co-products) = 2.42
- NER of palm biodiesel (with co-products) = 3.58
- Co-product utilization is a key to improve the energy ratio
- If the wastewater in the palm oil mill is utilized for biogas production, the NER of the palm biodiesel will increase to 3.70

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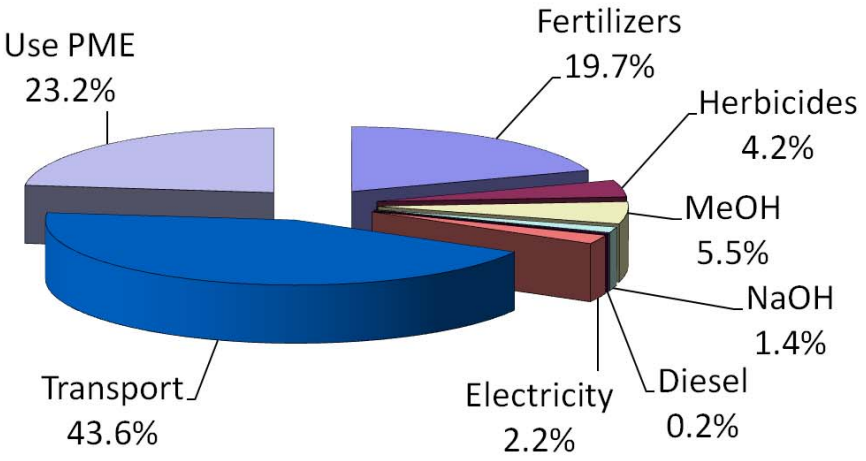
Life cycle GHG emissions of palm biodiesel production and use

Life cycle GHG emissions = 0.67 kgCO_2e/L



Pleanjai , Gheewala and Garivait (2009), Int J Global Warming, (in press)

Concluding remarks

- The life cycle GHG emissions of palm biodiesel are about one-fifth that of diesel
- A fuel switch from diesel to biodiesel (3.02 MLD) by 2011 could contribute to an estimated reduction in global warming potential by 2.8 million ton CO_2e per year
- Land use change is not included in these calculations as the existing oil palm plantations have been there for over three decades and new plantations are planned on acidic soil in the central region of Thailand, where currently other crops are not viable
- Palm biodiesel will support the Thai government's policy to promote biodiesel use in transportation in Thailand with regard to reducing crude oil imports as well as Thailand's commitment towards climate change mitigation

Future study

- Preliminary studies on oil palm plantation on acidic soils as well as existing rubber and cassava plantations have shown positive impacts of GHG emissions
- Carbon storage in oil palm plantations – this has not been included in this study but certain standards (e.g. PAS2050:2008) do include such considerations