Life Cycle Aspects of Liquid Biofuel Use in the Philippines

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Background

Main driving forces behind renewed interest in bioenergy for transport in the Philippines:

- Surging petroleum prices (indigenous fuels)
- Kyoto Protocol commitments (low-carbon energy)
- Urban air quality problems (clean fuels)

Key Statistics (DOE, 2004)

Parameter	Value	Year
Total primary energy (10^6 bfoe)	328	2008
Renewable energy[1]	27.9%	2008
Transportation energy	31.5%	2002
Self-sufficiency	54.6%	2008
Gasoline demand (10^6 bfoe)	41	2010
Diesel fuel demand (10^6 bfoe)	31	2010
CO_2 emissions[2] (10^6 tons)	69.7	2008
	87.1	2013

[1]Relative to primary energy

[2]Energy-related emissions

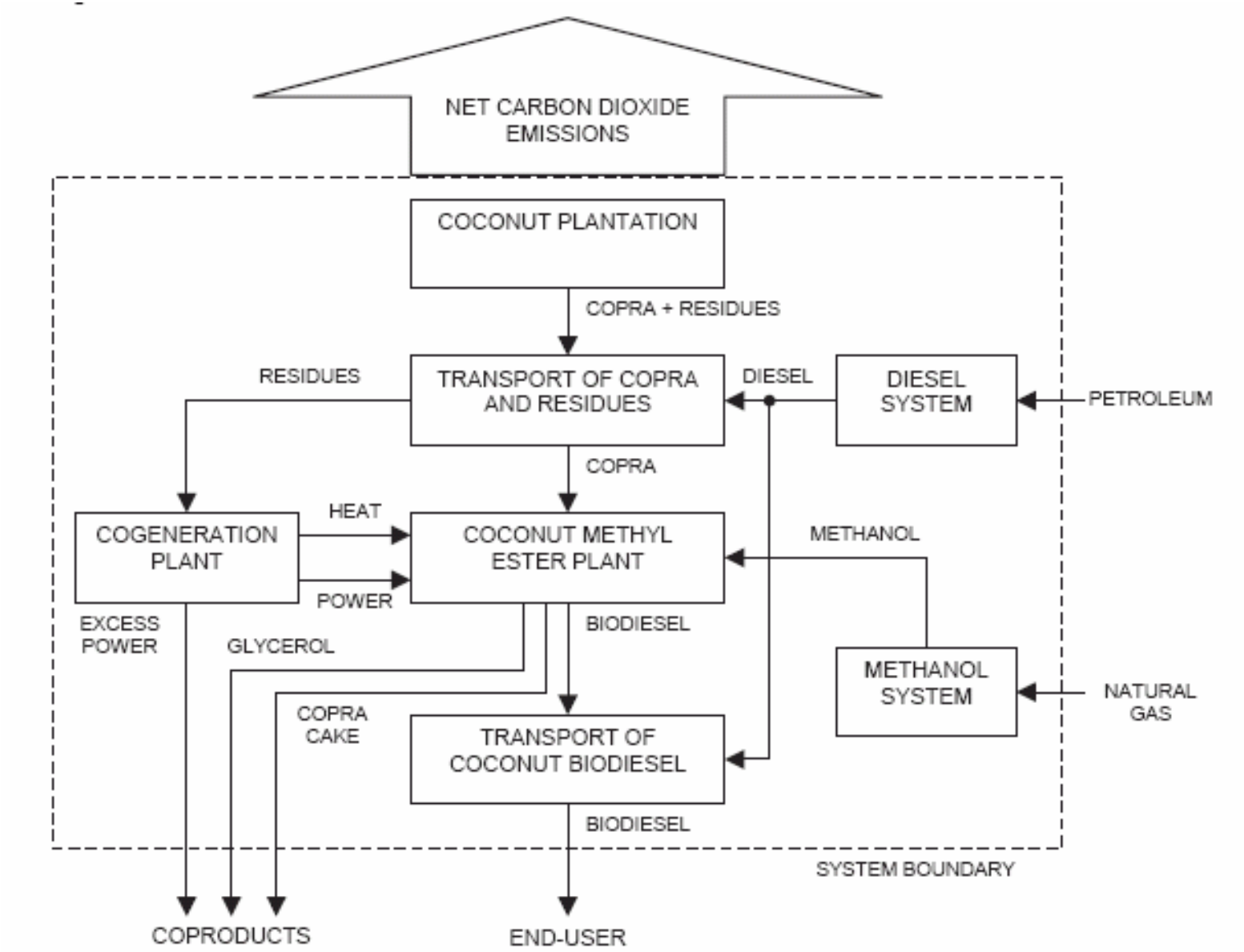
Biomass Energy for Transport

- Methyl ester or biodiesel
  - Coconut oil derived
  - Other oil crops
  - Industrial waste oil and grease
- Ethanol
  - Sugarcane
  - Starchy crops (corn, cassava)
  - Cellulosic waste
- Other biomass
  - Bagasse
  - Coconut shell, husk
  - Corn stover

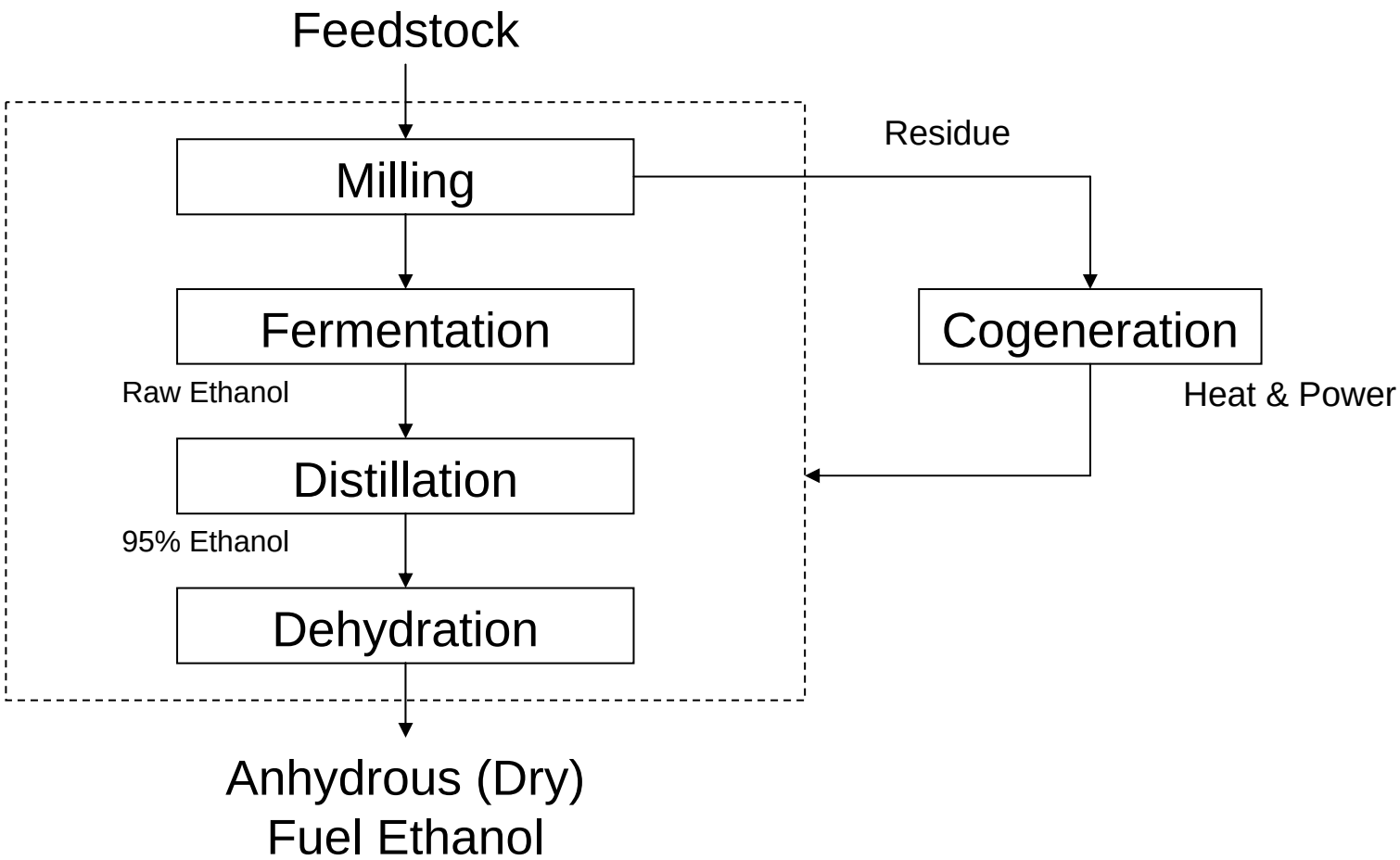
Liquid Biofuels – Initial Targets

- Coconut oil methyl ester (CME)
  - Additive for diesel (~1%)
  - Limited commercial availability – sold in 1 liter HDPE bottles
- Ethanol
  - Additive for ethanol (E5 – E10)
  - Several plants under currently under construction

Simplified CME Life Cycle



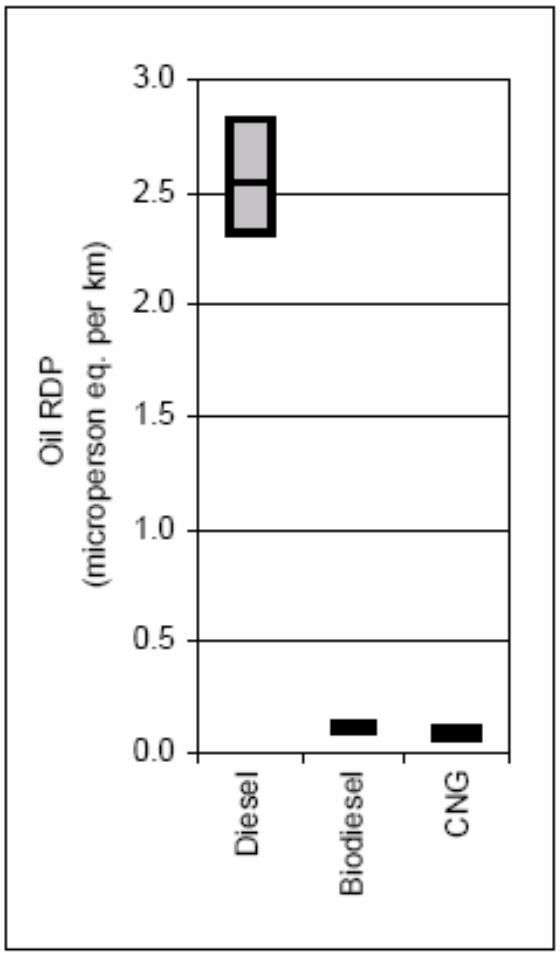
Simplified Bio-Ethanol Life Cycle

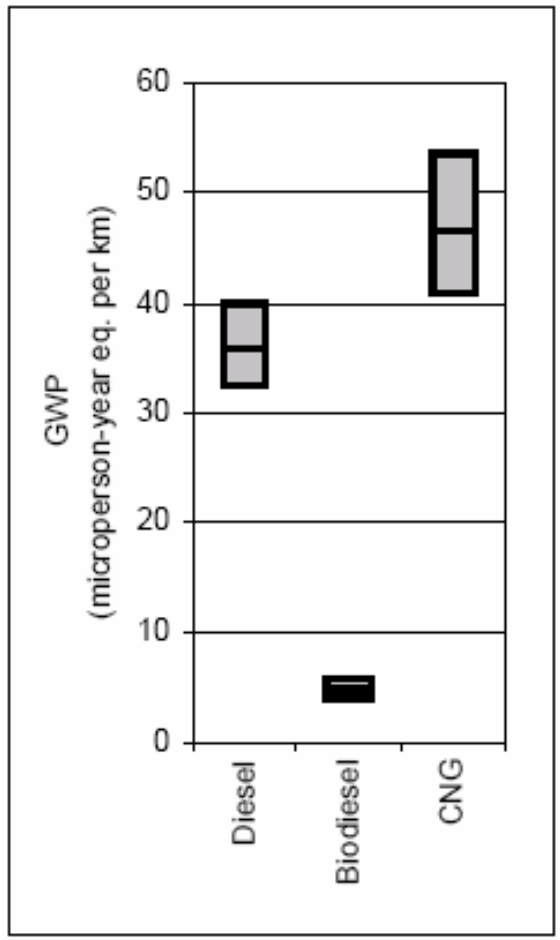


Comparative Net CO_2 Reductions (vs. Gasoline or Diesel)

Researcher	Fuel/Feedstock	Relative Reduction
Tan & Culaba, 2002	E10	11%
Tan et al., 2004	Coconut Oil	> 81%
Sheehan et al., 1998	Soya Oil	78%
Wang, 1999	Soya Oil	55%
Beer et al., 2002	Canola Oil + ethanol	57 – 66%
Kaltschmitt et al., 1997	Rapeseed Oil	66%

GWP and Oil Depletion for Light Vehicles





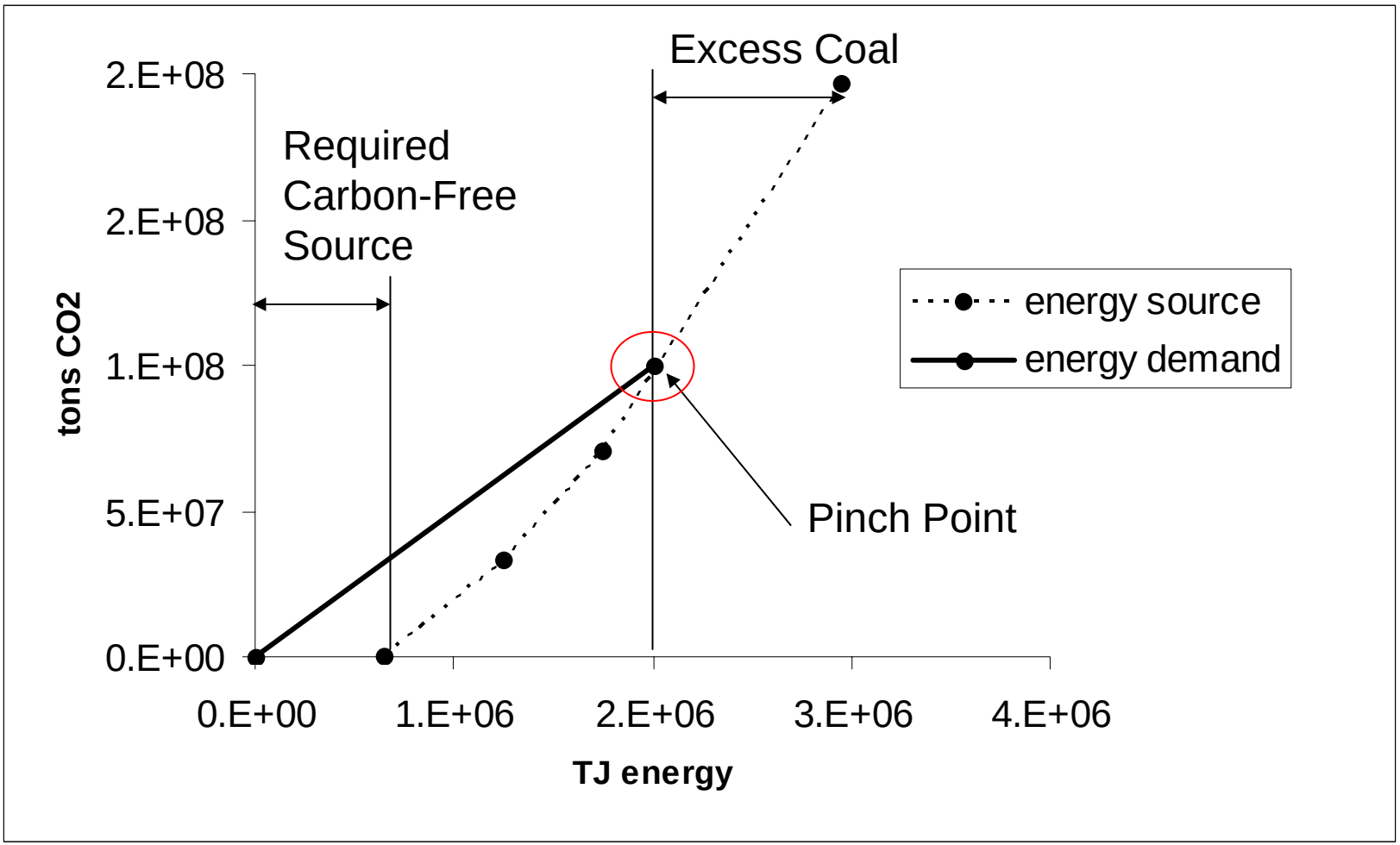
Key Net Energy Results

Fuel	Feedstock	Energy Ratio
Biodiesel	Coconut Oil	14.7 – 22.5
Ethanol	Corn	1.8
	Sugarcane	2.4 – 4.2

Current LCA Research Activities

- Generalized MINLP superstructure models for LCA of energy systems
- Evolutionary computing in LCA
- Artificial intelligence for decision support in LCA
- EMERGY modelling
- Pinch analysis-based energy sector planning models

Pinch Analysis for Energy Planning



Issues in Biofuel Use

- Economic aspects
  - Network externalities/technology inertia
  - Cost of production
  - Food vs. fuel
- Supply limitations
  - Implications of agricultural intensification strategies

Conclusions: LCA and Bioenergy

The key needs in our region are:

- Use of life cycle models to support policy decisions
- Development critical mass of LCA practitioners/users
- Compilation of national/regional LCI databases
- Development of life cycle methodology

Thanks for your time and attention

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