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XVI REUNIÓN TÉCNICA NACIONAL DE Palma de Aceite

Bienvenidos

Tecnología e innovación por una palmicultura colombiana resiliente

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Tecnología e innovación **por una palmicultura colombiana resiliente**

Performance analysis of a new circular palm oil mill set-up

Preliminary results

Análisis del desempeño de un nuevo concepto de planta de beneficio basada en economía circular

Work team

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El evento técnico sobre la agroindustria de la palma de aceite más importante de Colombia

Background of the project

- Colombia is an important source of palm oil for the Netherlands
- In 2018 an agreement was signed to collaborate on sustainable oil palm (with focus on circularity)
- Goal: to Increase efficient use of land, nutrients, biomass, and water
  - Circular downstream processing: more value out of palm residues
  - Intercropping and yield gap modeling: more yield per ha and less risk

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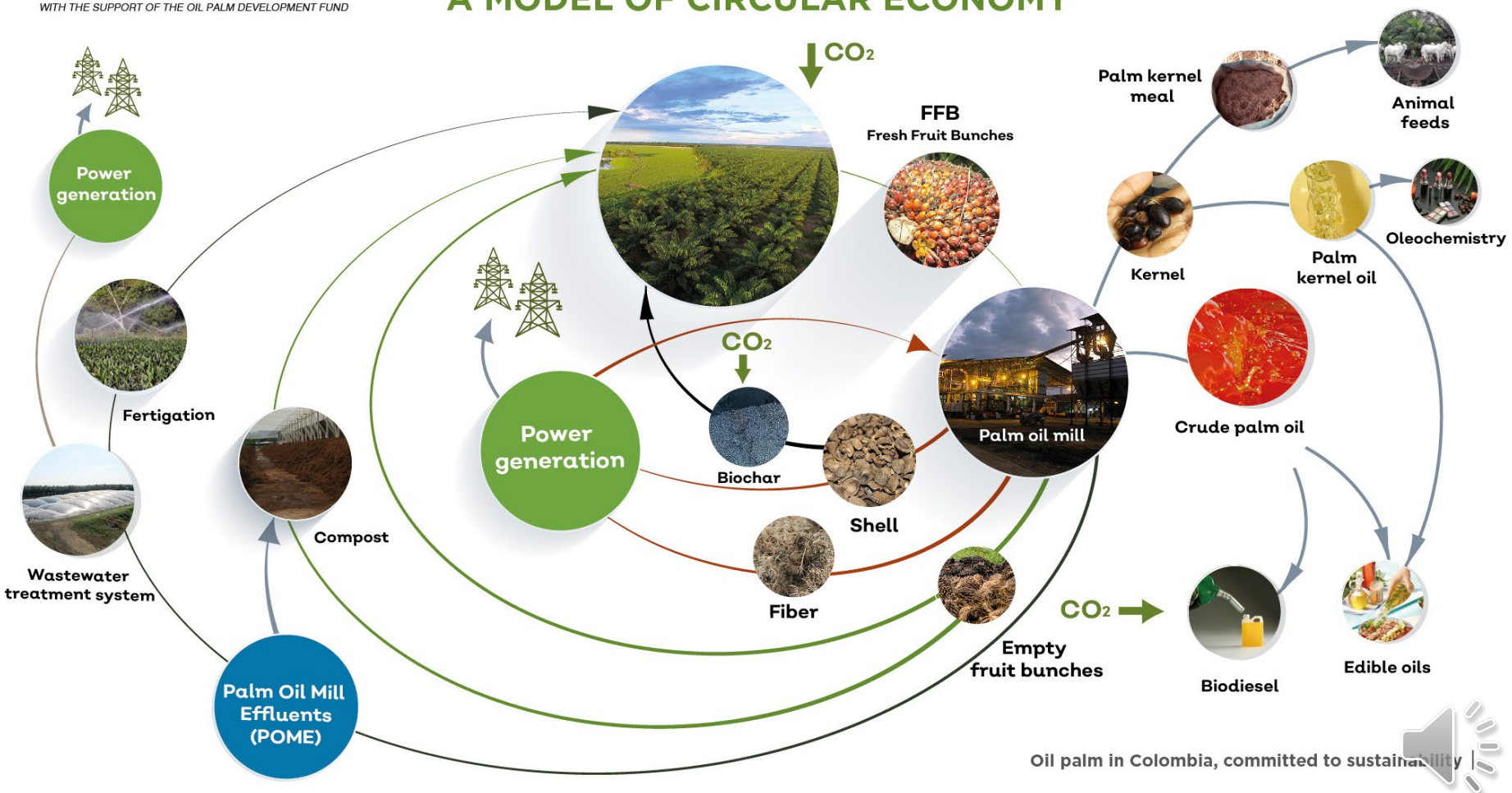
WITH THE SUPPORT OF THE OIL PALM DEVELOPMENT FUND

OIL PALM IN COLOMBIA
A MODEL OF CIRCULAR ECONOMY



Evaluated cases

Base case – Open POME ponds	Anaerobic digestion of POME	Anaerobic digestion of POME, EFB, and MF
• Biomass boiler (MF and Shell) • CH4 emission from POME ponds • EFB mulching	• Biomass boiler (MF and Shell) • EFB mulching • Surplus electricity to grid	• Boiler on biogas • Anaerobic digestion of EFB and POME • Surplus electricity to grid

Biogas instead of solid biomass as energy source

- **Biomass boiler (MF & Shell)**
  - Low thermal efficiency (60%)
  - Cyclone and electrostatic filter required
    - CAPEX and OPEX (electricity: 4.5 kWh/ton FFB)
  - Nitrogen is lost (emission)
  - Availability of minerals (P & K) in boiler ash?
- **Biogas from EFB & MF**
  - Thermal efficiency (87%)
  - Lower flue gas emissions and treatment
  - Biogas production for steam and electricity generation
  - Nutrient (N, P & K) value of sludge and effluent
  - Carbon in sludge available for soil
  - Extra process steps
    - Covered lagoon, H2S washer, biogas boiler, biogas generator

How to improve biogas yield?

- Steam treatment of EFB & MF before anaerobic digestion:
  - Faster digestion
  - More organic matter digested
  - Higher biogas production

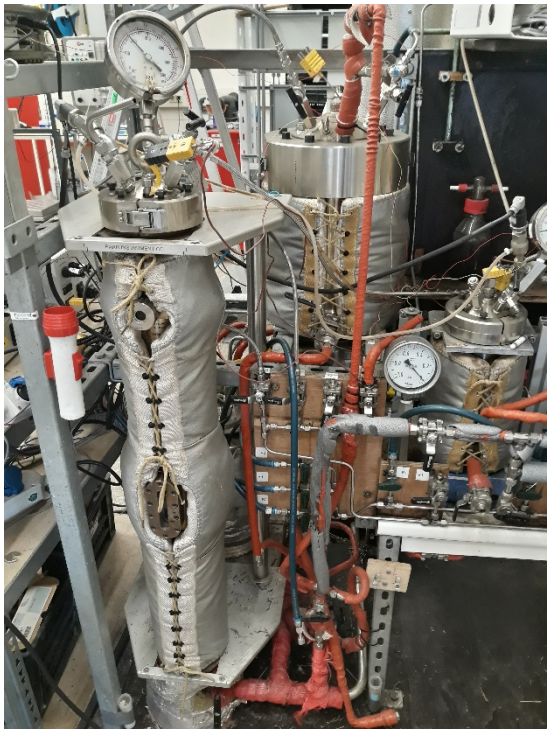
- Extra process step
  - CAPEX: Steam reactor
  - OPEX: Steam (~200°C)

Steam treatment of EFB & MF and digestion experiments

Experiments @Wageningen Research

- Untreated
  - EFB: 350 m3 biogas/ton OM, 56% OM digested
  - MF: 260 m3 biogas/ton OM, 35% OM digested

- Steam treated (200°C)
  - EFB: 475 m3 biogas/ton OM, 66% OM digested
  - MF: 360 m3 biogas/ton OM, 46% OM digested



Increase 35%
EFB biogás yield

Increase 38%
MF biogás yield

Assessment methodology

Scenario design

- Mass, energy and nutrient balance
- POM size: 30 t FFB h^{-1}
- Operation time: 5000 h y^{-1}
- Plantation area: 8200 ha
- OER: 21%

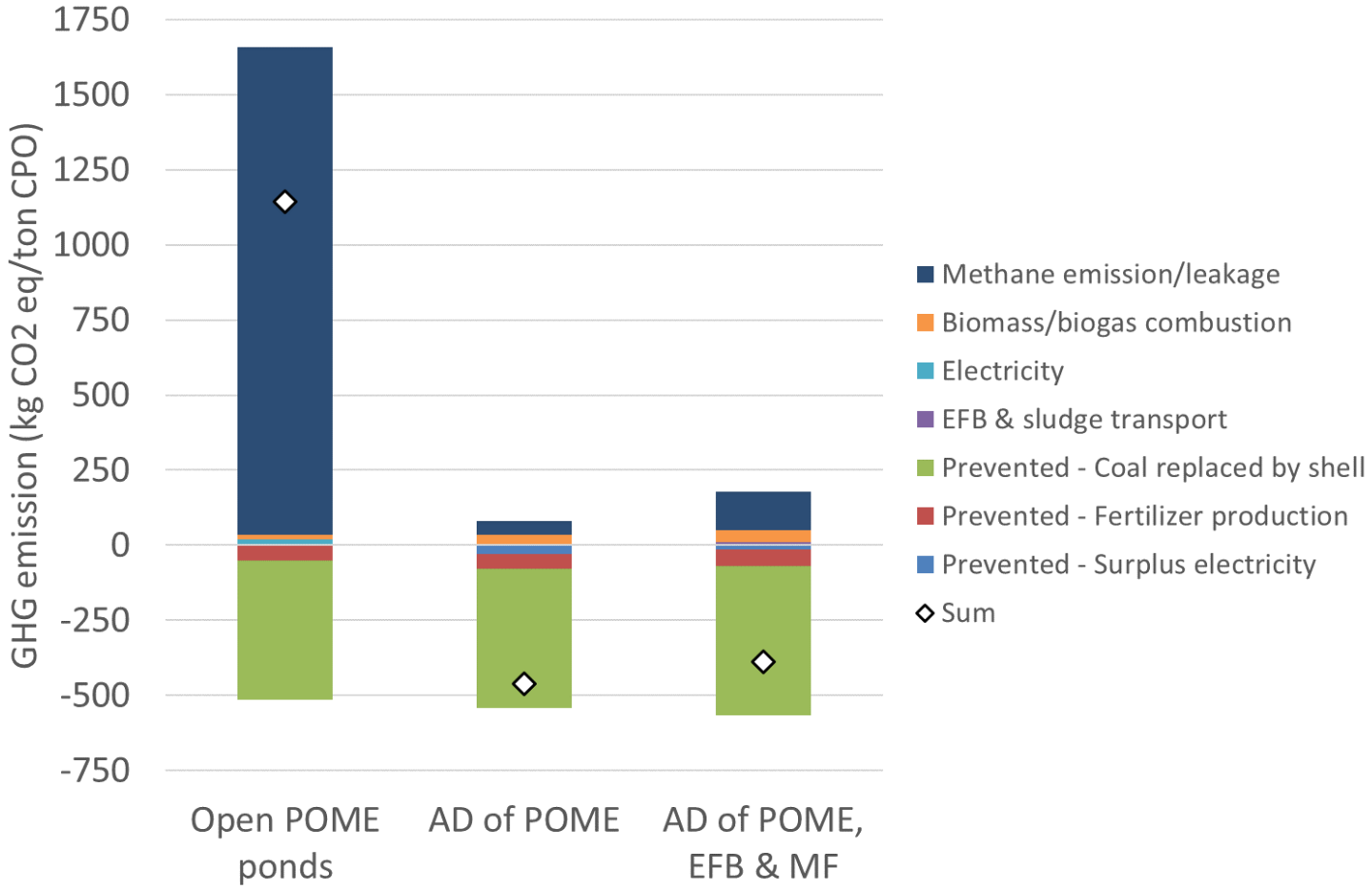
Environmental performance

- Methane emission
- Combustion emissions
- Electricity
- EFB & sludge transport
- Coal replaced by shell
- Fertilizer production
- Power surplus

Economic performance

- CPO, Palm kernel and PKS selling
- Savings on fertilizer
- Prevented CO_2eq emissions
- Electricity
- CAPEX
- OPEX
- VNA, IRR, and payback time

Environmental performance (preliminary)



Economic performance (preliminary)

		Open POME ponds	AD of POME	AD of POME, EFB & MF
CAPEX	M$	21.4	22.1	21.4
Average cash flow	M$/y	4.0	4.7	4.7
Simple pay-back period	y	5.4	4.7	4.6
Net present value	M$	14.3	20.4	20.6
Internal rate of return		13%	17%	18%

- The scenario with open POME ponds performs significantly worse compared to the other scenario's

Value of EFB and MF

- Biogas valorisation per energy use
  - Selling price: USD 0.06 – 0.13/kWh
  - EFB: USD 18 - 40/ton
  - MF: USD 24 – 53/ton

- Nutrient value (N, P, and K):
  - EFB: USD 15/ton
  - MF: USD 16/ton

- Soil carbon value not included (yet)

Circularity analyses (preliminary)

Anaerobic digestion of EFB and MF:

- Nitrogen to plantation increases from 27% to 42%
- Soil carbon to plantation increases from 25% to 57%

  (expressed as % of component in FFB)

- Availability of P and K better in sludge and effluent compared to mulched EFB and boiler ash?

Discussion

- Biogas instead of biomass
  - Easier and cheaper operation
  - Better air quality
  - Lower nitrogen loss
  - P and K could be more available for soil
  - More organic matter is water holding capacity and productivity (not incorporated in the economic performance yet...)
  - Improve GHG emission impact from 1142 kg CO_2eq/t CPO to aprox. -370 kg CO_2eq/t CPO
  - Better markets access

Acknowledgment

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Gracias