Identifying opportunities to manage palm oil mill effluent (POME): the case of Indonesia

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Research question:

How can palm oil mills adopt sustainable pathways for the treatment of POME?

Context:

- High methane emissions from POME (55% of GHG emissions of mill operations)[1]
- By 2020 all certified palm oil mills should avoid methane emissions[2]
- Proven technologies for POME treatment available [3]

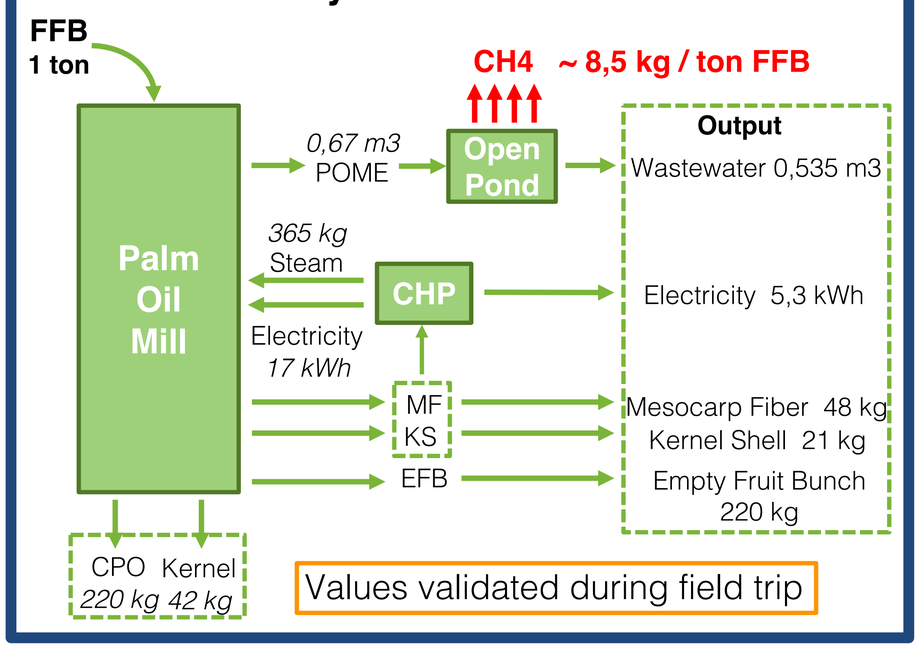
BUT

- Low incentives for POM to adopt methane capture technologies [3]

Research Objectives:

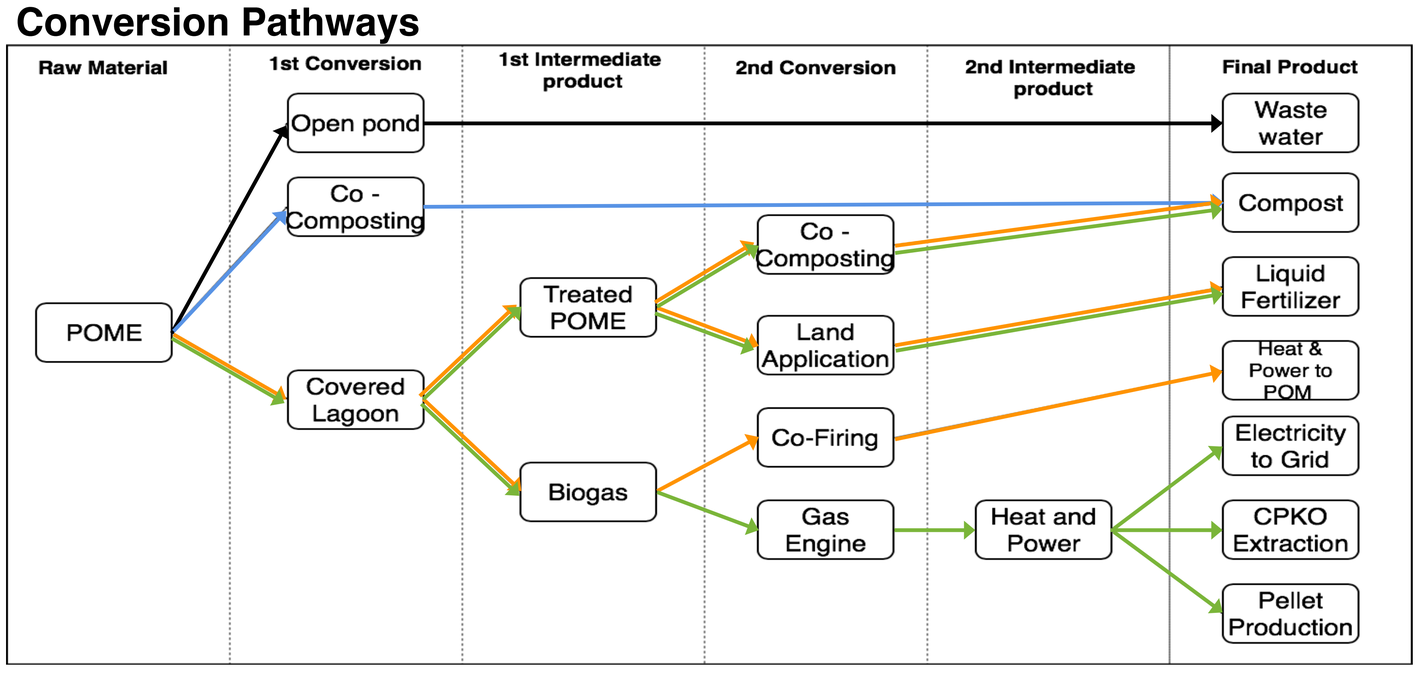
- ✓ Identify POME treatment pathways
- ✓ Propose various biorefinery concepts
- ✓ Sustainability Evaluation: Economic, Environmental and Social
- ✓ Propose the optimal solution in grid connected & off-grid palm oil mills

Conventional System



Values validated during field trip

Conversion Pathways



Field Trip

- ✓ IOPRI Medan
- ✓ SMART research center

Multi Criteria Analysis

Ec1 - **CAPEX** Capital Expenditure

Ec2 - **Profit**: Profit per year

Ec3 - **PBT**: Pay back time

Ec4 - **IRR**: Internal Rate of Return

Economic Impact

En1 - **GWP**: Global Warming Potential

En 2 - **NEB:** Net Energy Balance

Environmental Impact

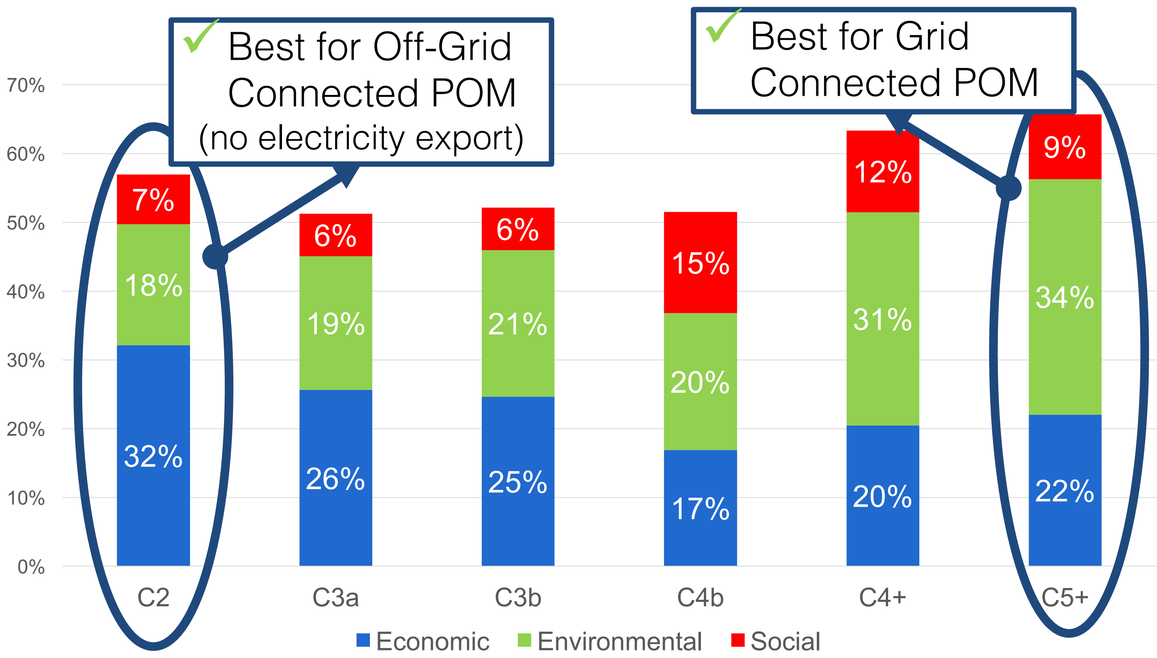
S1 – **Jobs**: n° jobs created

S2 – **Elec**: Electrification Potential

Social Impact

Summary of Biorefineries Selected	
C1	Conventional
C2	Co-composting
C3b	Co-firing + Co-composting T-POME
C4a	ICE + T-POME land application
C4b	ICE + Co-composting T-POME
C4+	ICE + Pellet + Land application
C5+	ICE + Pellet + CPKO + Land application

$$Sustainability\ Score = Ec * W_{Ec} + Env * W_{Env} * Soc * W_{Soc}$$



Note: the conventional case (C1) is used as reference for part of the scoring system

Main Takeaways

- ✓ Biorefinery concepts provide pathways to comply with the strictest environmental regulations for treating POME while increasing the revenues for the palm oil mill
- ✓ The new concepts achieved positive impact on all categories
- ✓ Alternatives with high integration of residues treatments (i.e. pellet and CPKO produ ction) achieved the best results
- ✓ Generation of electricity from biogas is not convenient if it's solely sold to the grid
- ✓ Biorefinery with co-composting of raw POME and EFB (C2) is the most suited for off-grid POMs (low investment & no electricity export)
- ✓ Biorefinery with integration of pellet production and kernel crushing plant (C5+) achieved the best results for grid connected palm oil mills

References:

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[2] APEC, 2017. "*Strategy for Large-Scale Implementation of Biogas Capture from Palm Oil Mill Effluent and Reuse for Renewable Electricity Generation*", Asia-Pacific Economic Cooperation, Singapore.
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[4] Garcia-Nunez, J.A., Ramirez-Contreras, N.E., et al., 2016. Evolution of palm oil mills into bio-refineries: Literature review on current and potential uses of residual biomass and effluents. *Resources, Conservation and Recycling*, 110, pp.99–114