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Addressing Sustainability of Natural Rubber Industry through Life Cycle Assessment

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Growing Trends on Global Awareness in Response to Environmental Threats

Negate impacts of anthropogenic activities on environment to ensure sustainability:

- Climate change/Global Warming
  Reduce greenhouse gas emission and air-borne pollutants
- Depleting natural resources
  Reduce resource consumption (abiotic)
- Health–related issues
  Reduce the use of hazardous substances
- Accumulating solid wastes
  Reduce resource consumption and waste recycling

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Drivers of Environmental Awareness

Europe
- EU policies such as IPP, REACH, EuP, RoHS
- Directives for Promotion of Renewable Energy
- Green Public Procurement
- Tyre Performance Labeling

Japan
+ Law for a Sound Material-Cycle Society
+ Green Procurement Policy in government sector
+ Product Green Promotion Program
+ Eco-Labeling Program

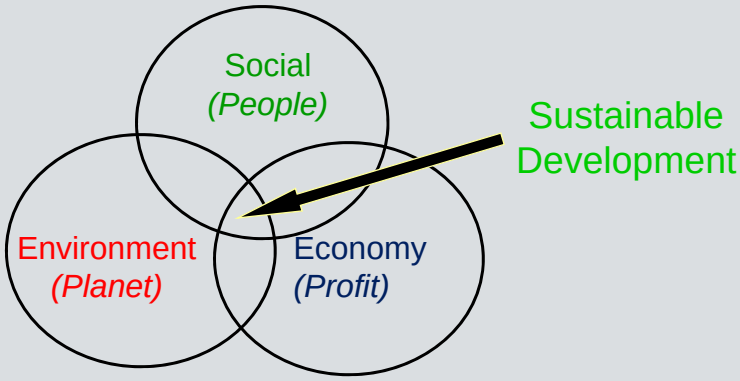
USA
* USEPA Product Stewardship Program

Clean Development Mechanism (CDM) – Certified Emission Reduction (Kyoto Protocol) (2008-2012)

Conceptual Approach

The Dominant Model

Dependency of economic, social and environmental aspects (sustainability pillars)



Sustainability is not only about environmental sustainability but to achieve a balance, interdependent and mutually reinforcing economic, social and environmental aspects

Conceptual Approach

Sustainable development is a *process of progress* in which:

- exploitations of resources
- strategy for investments
- technological development and innovations
- institutional changes

are made consistent with both **present and future** requirements.

Sustainable development is not only about environment but about efficient use of resources

Sustainable Rubber Industry?

Upstream (Plantation) → Midstream (Processing) → Downstream (manufacturing)

Status at an initial stage of implementation:

- Optimization of resources
  Renewable natural rubber, energy reduction, non-toxic chemicals or raw materials
- Environmental Impacts
  Waste minimization and utilization, recycling and environment management systems (ISO-14000 series standards)
- Technological development
  R&D in cost-competitive and eco-efficient technologies (green rubbers, green rubber products)
- Institutional changes
  Comprehensive environmental regulations

Life Cycle Assessment

- LCA is an environmental management method for the quantitative evaluation of material resources invested, the environmental burden and the environmental impact on the earth of a product or service through all stages of its life cycle (Narita, 2004)
- LCA is an indicator for sustainability
- LCA assess the environmental aspects and potential impact of a product through;
  - Compiling an inventory data concerning inputs and outputs of a product system
  - Evaluating the potential environmental impact associated with those inputs and outputs
  - Interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study

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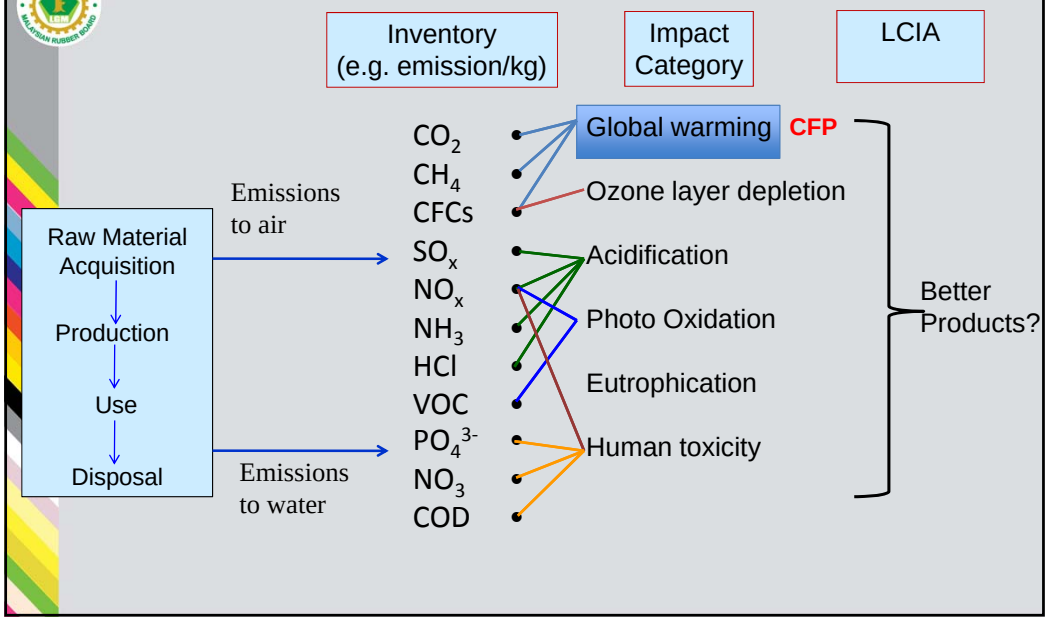
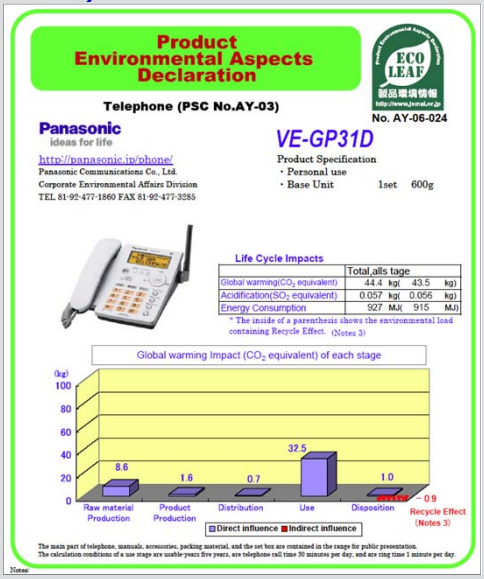
Life Cycle Impact Assessment (LCIA)



Examples of Life Cycle Assessment (LCA) & Carbon Footprint (CFP) in Practice

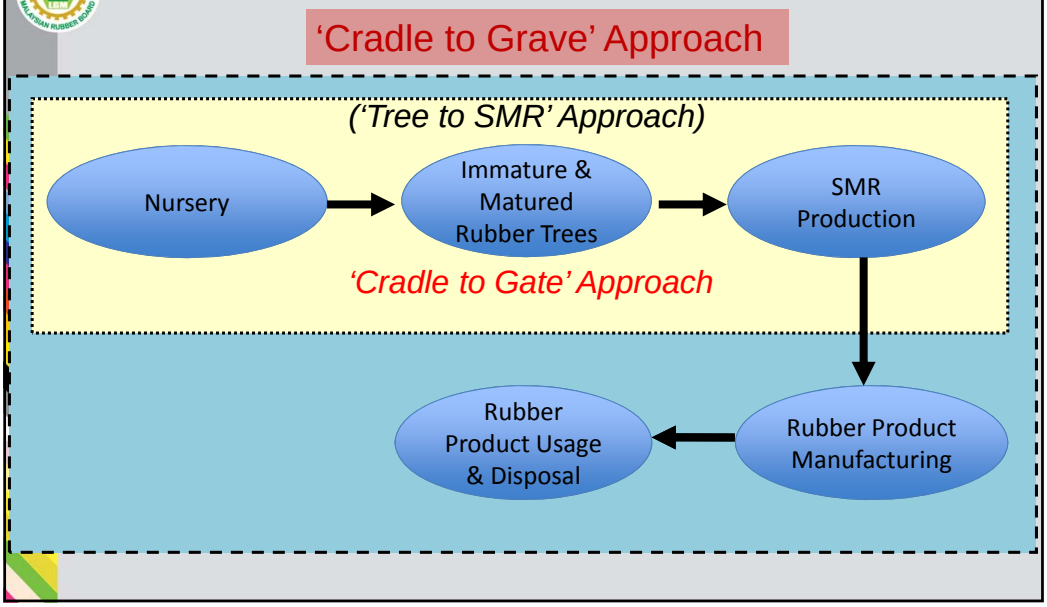
Type I



Type III

LCA & CFP for Standard Malaysian Rubber (SMR) Production

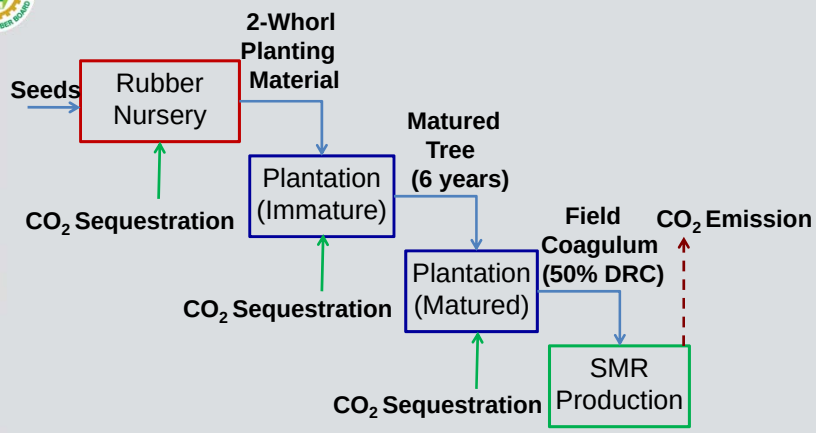
System Boundary of LCA for SMR Production



Scope of LCA Study

- Functional unit in this study will be the production of 1000 kg of SMR 10/20
- All calculations of masses and emissions in this study are based on the defined functional unit
- All environmental Impact categories (especially CFP) in this study are based on the defined functional unit

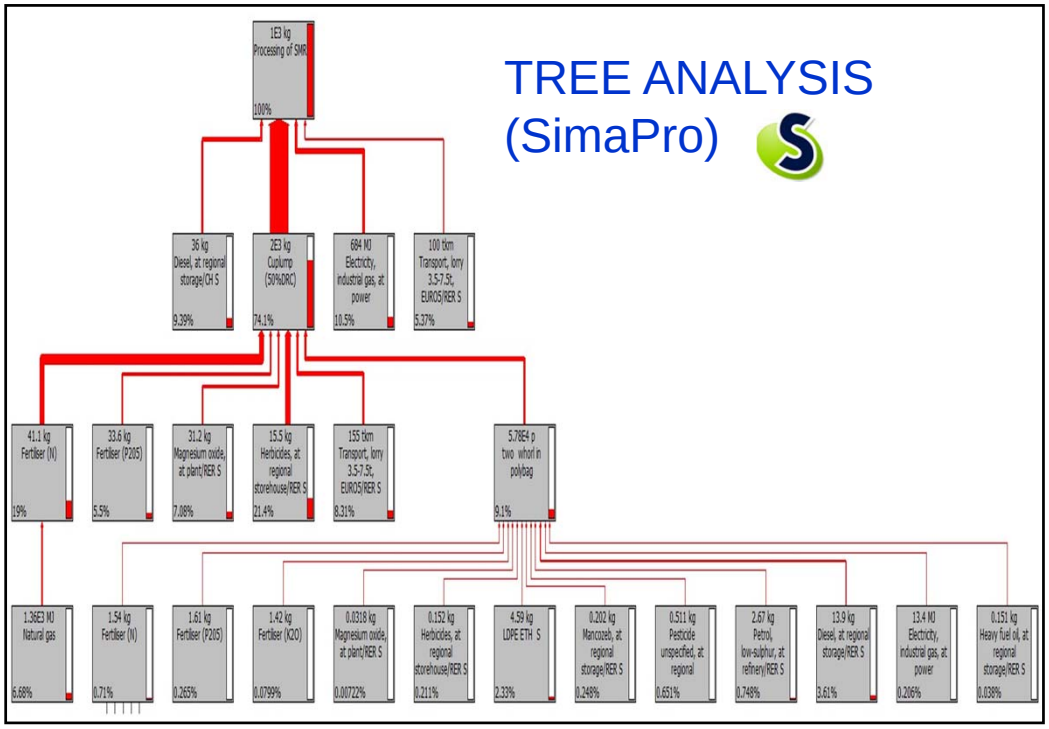
System Boundary of LCA for SMR Production



Input-Output Table for SMR Production (Cradle to Gate)
FU: 1000 kg of SMR 10/20

Input	Quantity	Unit	Output	Quantity	Unit
Cuplump (50% drc) and its upstream processes*	2000	kg	SMR 10/20	1000	Kg
Water (untreated)	19860	L	Methane ($CH_{4)}$	3.43	Kg
Diesel	36	Kg	COD	1.61	Kg
Electricity	190	kwh	Suspended solids	0.53	Kg
Transport	100	Ton.km	Total Nitrogen	0.51	Kg

* *Two-whorl and immatured/matured rubber tree production*

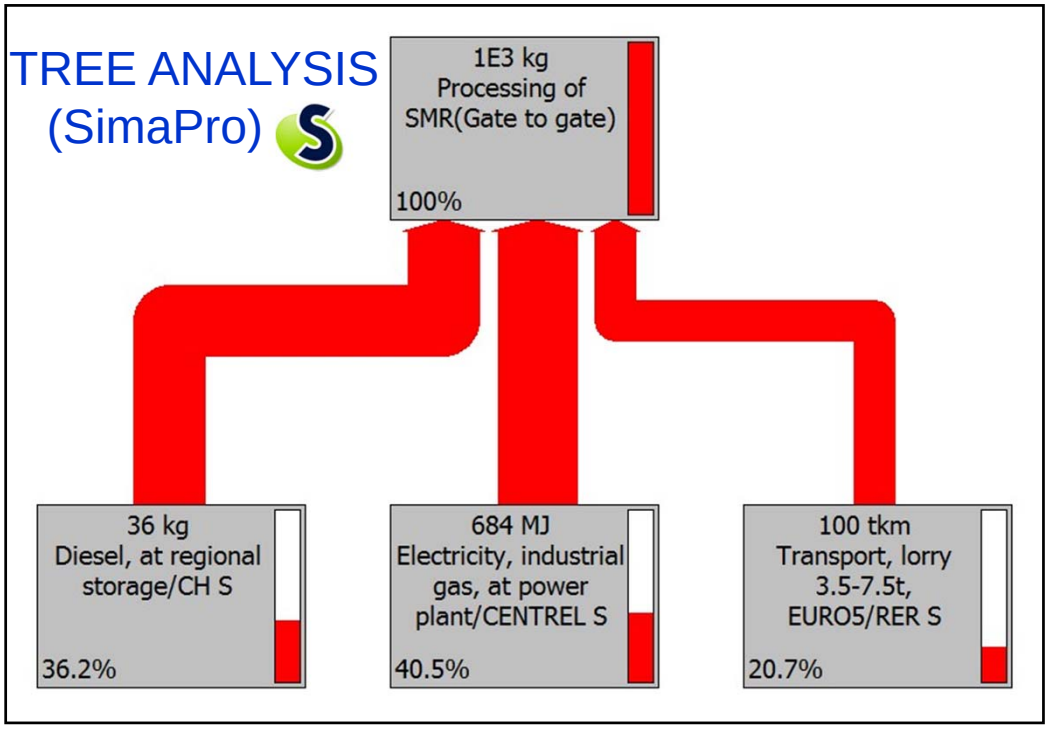


Input-Output Table for SMR Processing (Gate to Gate)
FU: 1000 kg of SMR 10/20

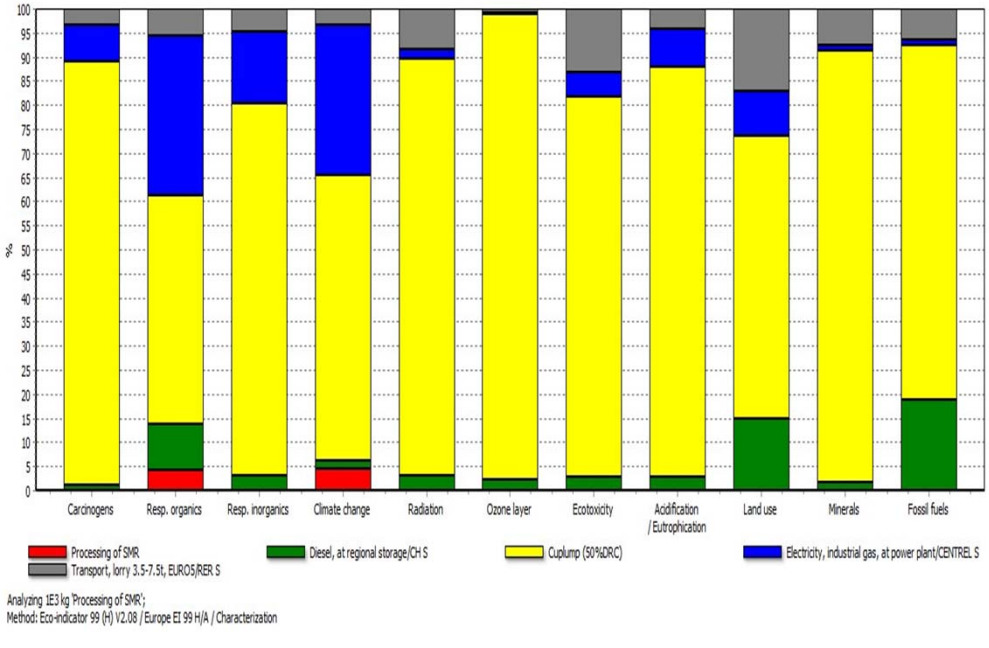
Input	Quantity	Unit		Output	Quantity	Unit
Water (untreated)	19860	L		SMR 10/20	1000	Kg
Diesel	36	Kg		CH_4	3.43	Kg
Electricity	190	kwh		COD	1.611	Kg
Transport	100	Tan.km		Suspended solid	0.529	Kg
				Total Nitrogen	0.507	Kg

COD – Chemical Oxygen Demand of Final Effluent

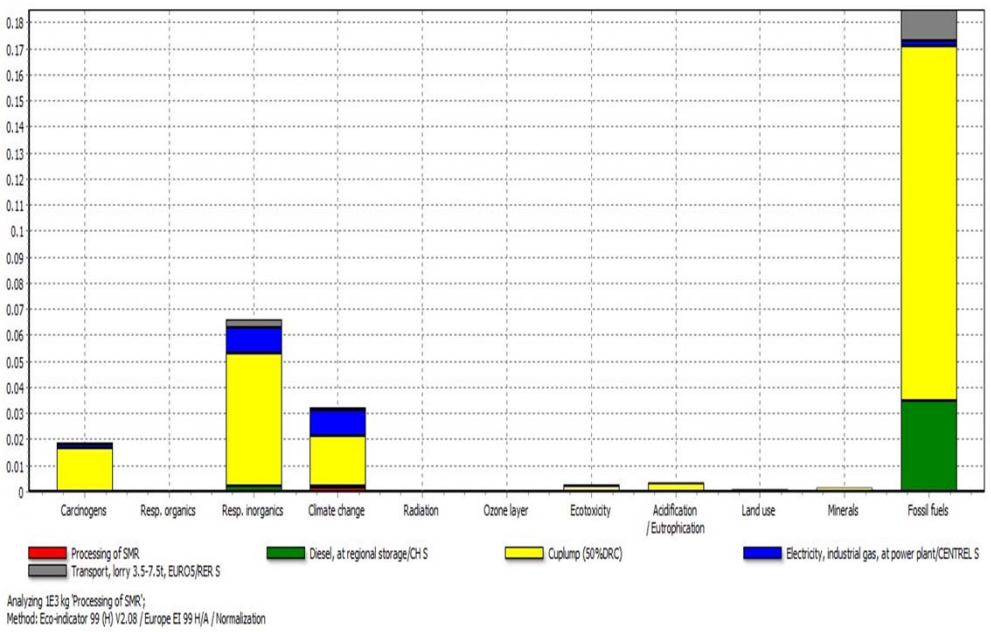
TREE ANALYSIS (SimaPro)



Impact Assessment – Characterization based on FU of 1000kg SMR 10/20

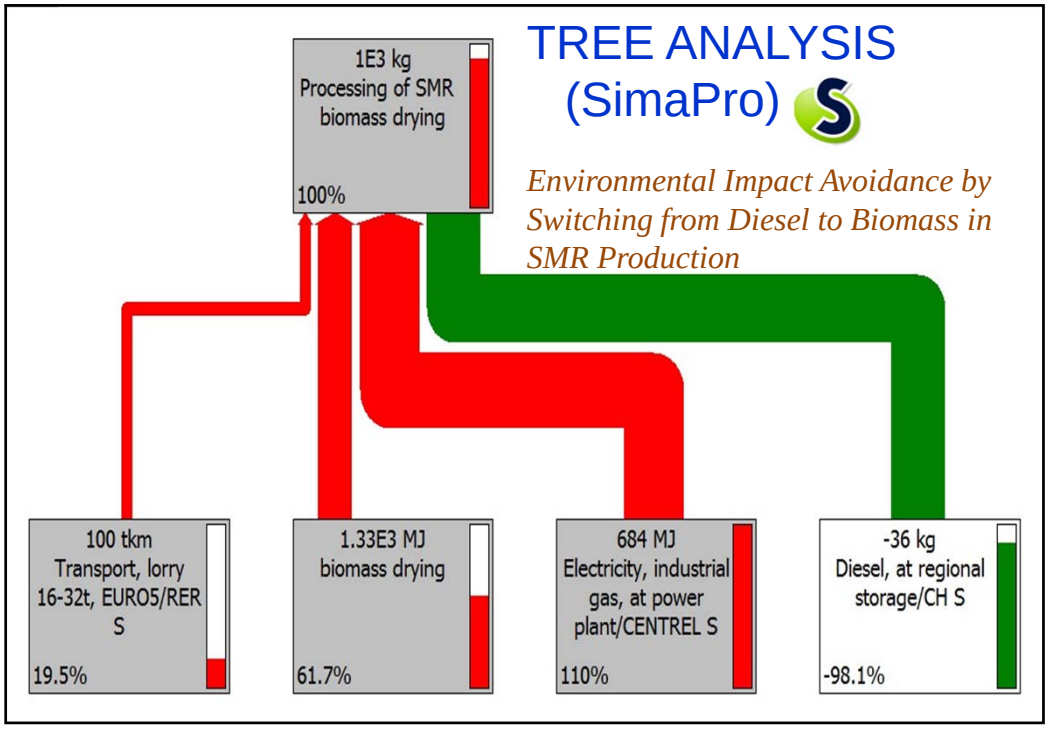


Impact Assessment – Normalization based on FU of 1000kg SMR 10/20



Impact Assessment – Interpretation (Screening CFP)

Life Cycle Stage	Carbon Footprint (CFP)
SMR Production (Cradle to Gate)	1.10 kg CO_2/kg SMR
CO_2 sequestration 'Cradle to Gate'	-6.12 kg CO_2/kg SMR (5.02 kg CO_2/kg SMR of net sequestration)


TREE ANALYSIS
(SimaPro)
Environmental Impact Avoidance by Switching from Diesel to Biomass in SMR Production
1E3 kg
Processing of SMR biomass drying
100%
100 tkm
Transport, lorry 16-32t, EURO5/RER S
19.5%
1.33E3 MJ
biomass drying
61.7%
684 MJ
Electricity, industrial gas, at power plant/CENTREL S
110%
-36 kg
Diesel, at regional storage/CH S
-98.1%


Thank You