GHG EMISSION REDUCTION PRACTICES IN THE MALAYSIAN OIL PALM INDUSTRY BY CONVERTING WASTE TO WEALTH IN LINE WITH THE CIRCULAR ECONOMY APPROACH

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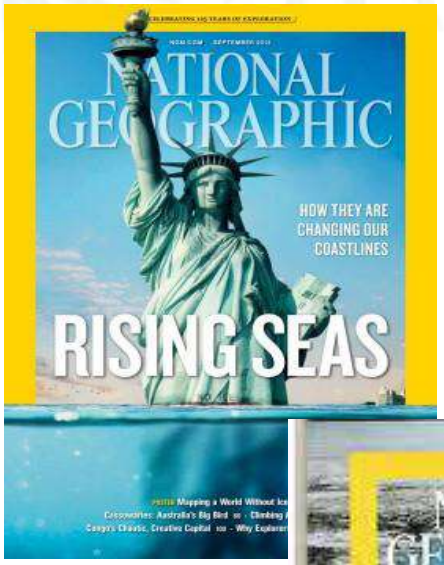
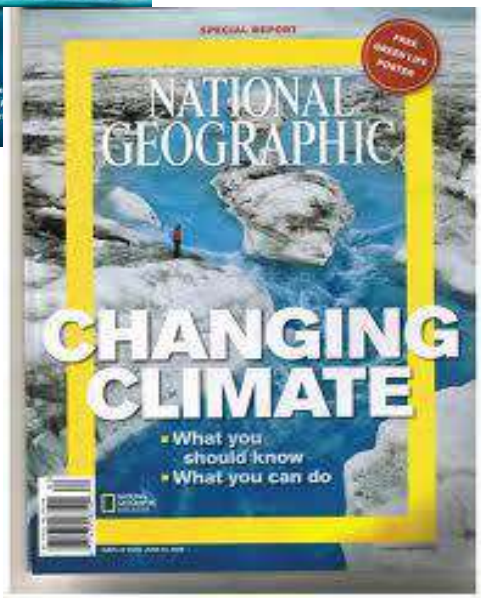
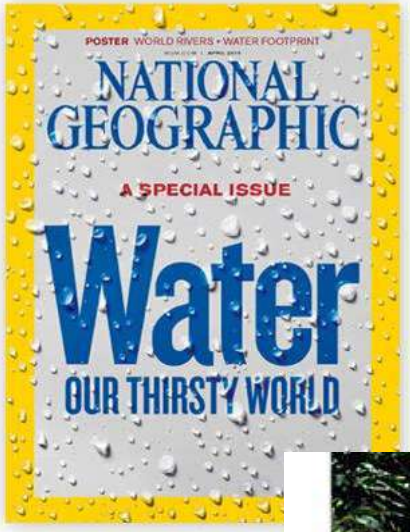
Malaysian Palm Oil Board

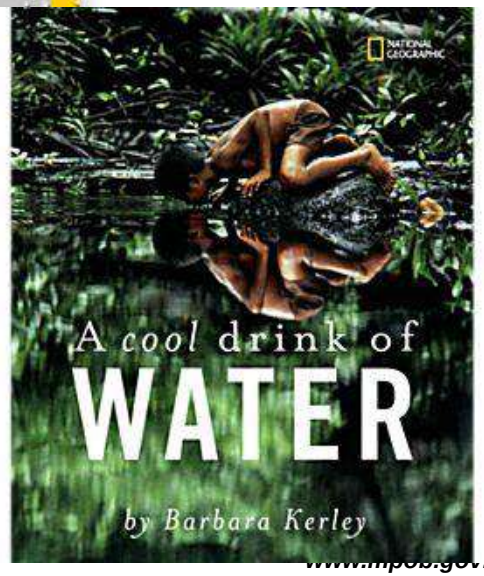
GLOBAL WARMING/ CLIMATE CHANGE

WATER SCARCITY







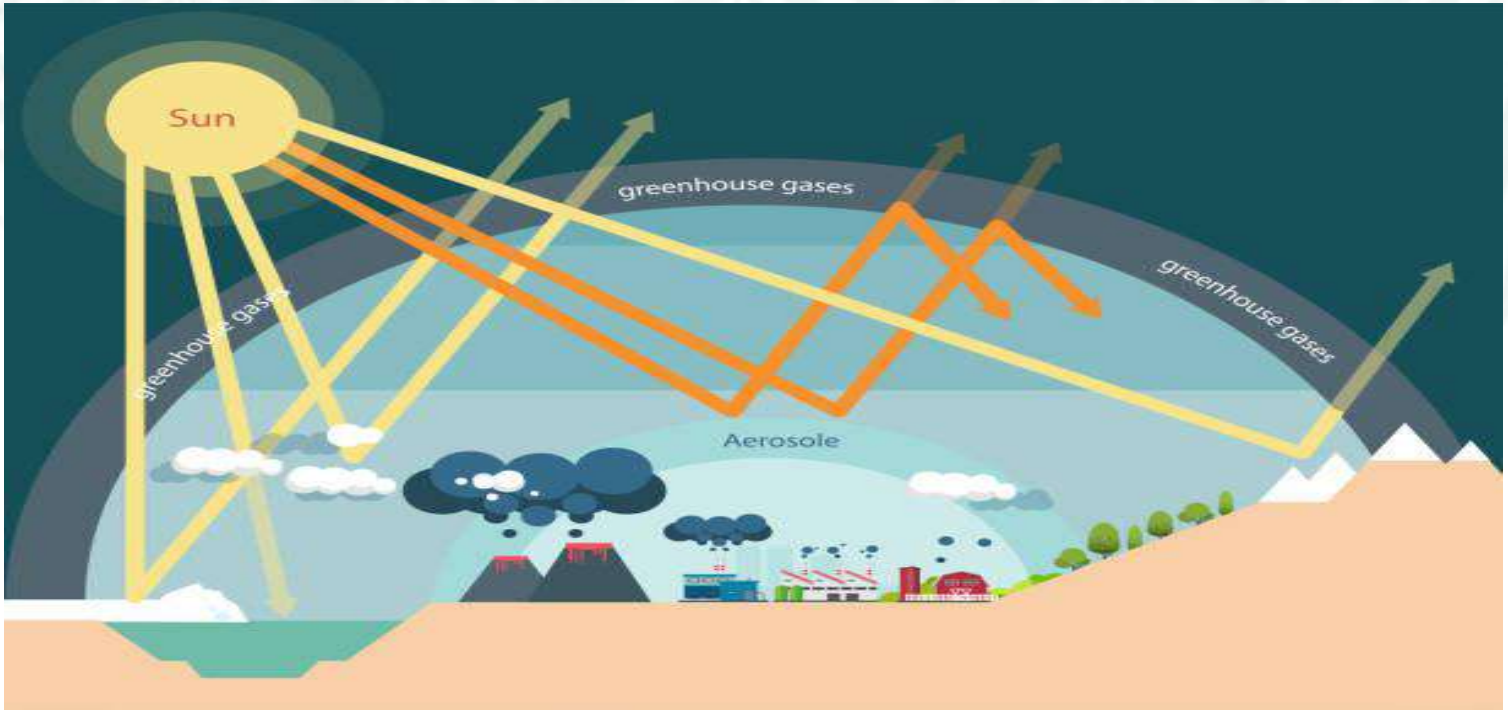


GLOBAL WARMING

Many regions, human well-being and ecosystem health are being seriously affected by changes in the global warming which is, caused largely by human activities.

Materials and energy is required right from raw material extraction- planting-harvesting- processing- manufacturing- use- reuse Disposal- Whole life cycle

GLOBAL WARMING – GREEN HOUSE EFFECT



Global warming or climate change happens when the balance is lost due to the reduction in the amount of radiation reflected back into space. Instead, these radiations are trapped and reflected into Earth by certain gases in the atmosphere. This double bombardment of radiation is the main cause for global warming.

GLOBAL WARMING POTENTIAL

Common Name	Global Warming Potential Values 100-Year Time Horizon
Carbon Dioxide	1
Methane	25
Nitrous Oxide	298
Trifluoromethane	14800
Difluoromethane	677
Fluoromethane	116

Global warming potentials (GWP) are a set of values created by the Intergovernmental Panel on Climate Change (IPCC) to compare the ability of a GHG to trap heat in the atmosphere as compared to each other

INTRODUCTION

- In 1999 the total oils and fats produced globally was 107.7 million tonnes and in 2019 this amount has more than doubled to 234.7 million tonnes.

- The oils and fats world production are predominantly championed by 2 main oils which are palm oil and soybean oil.

INTRODUCTION

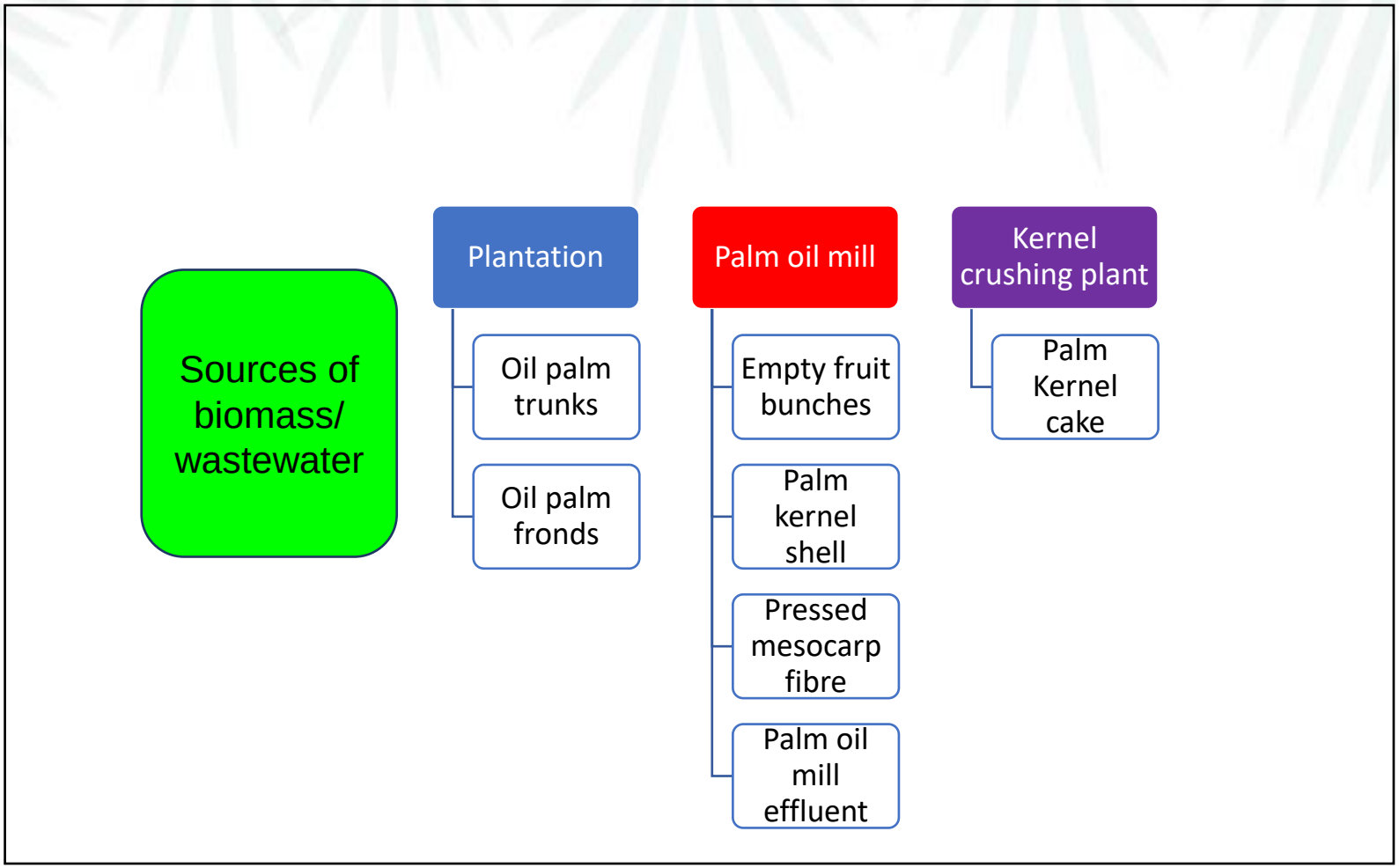
- In the year 2019 alone, the global production of palm oil was 75.34 million tonnes and soybean oil was 56.34 million tonnes.

- Malaysia has a total oil palm planted area of 5.9 million ha.

- Malaysian palm oil industry generates large amounts of biomass wastes totalling to approximately 80 million tonnes per annum.

- However, to what extent these biomasses are harnessed and utilised is hardly documented

SOURCES OF WASTES



PRODUCTION OF WASTES IN 2019

12.9 MILLION TONNES

PRESSED MESOCARP FIBRE

22.9 MILLION TONNES

EMPTY FRUIT BUNCH

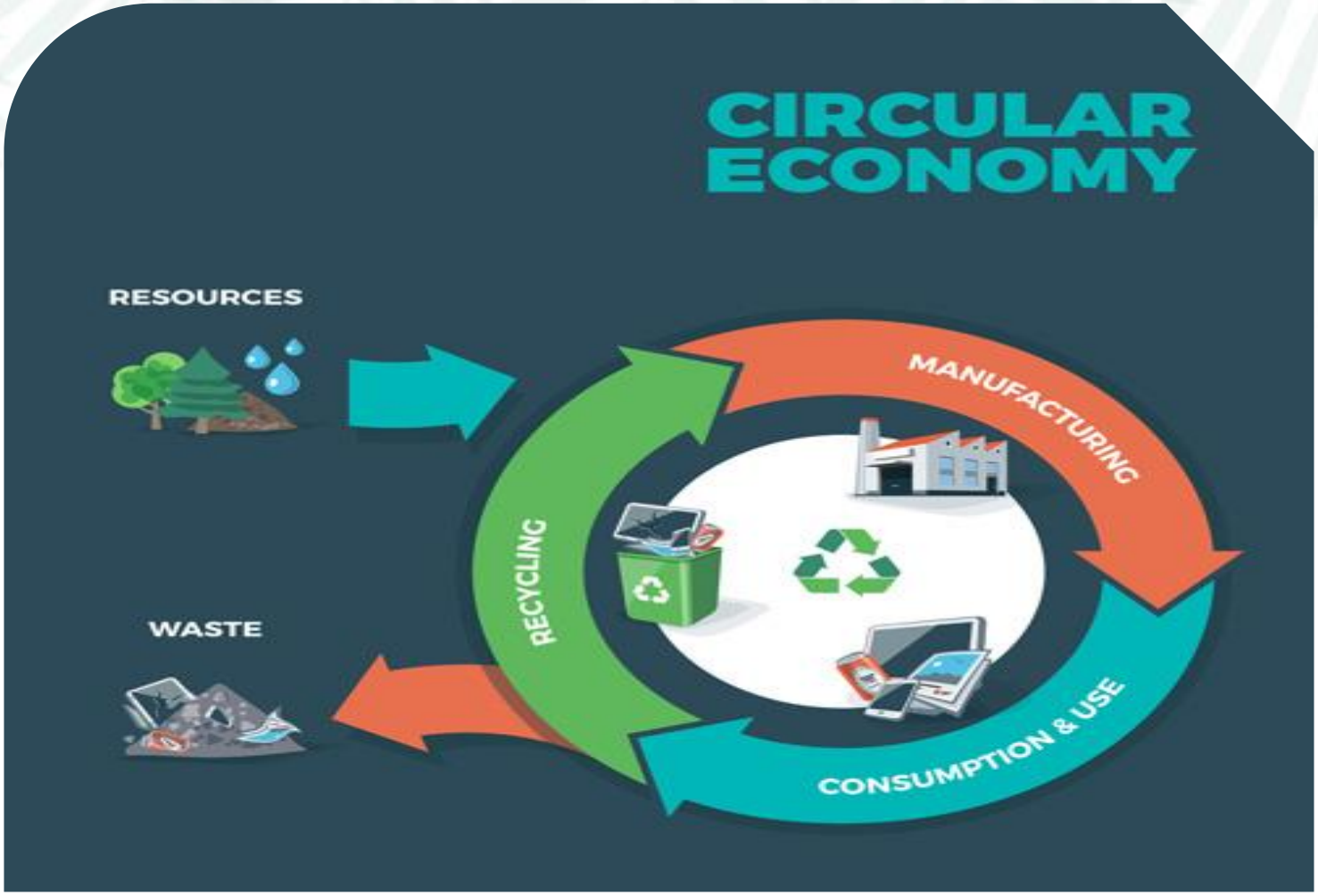
5.9 MILLION TONNES

PALM KERNEL SHELL

66.7 MILLION TONNES

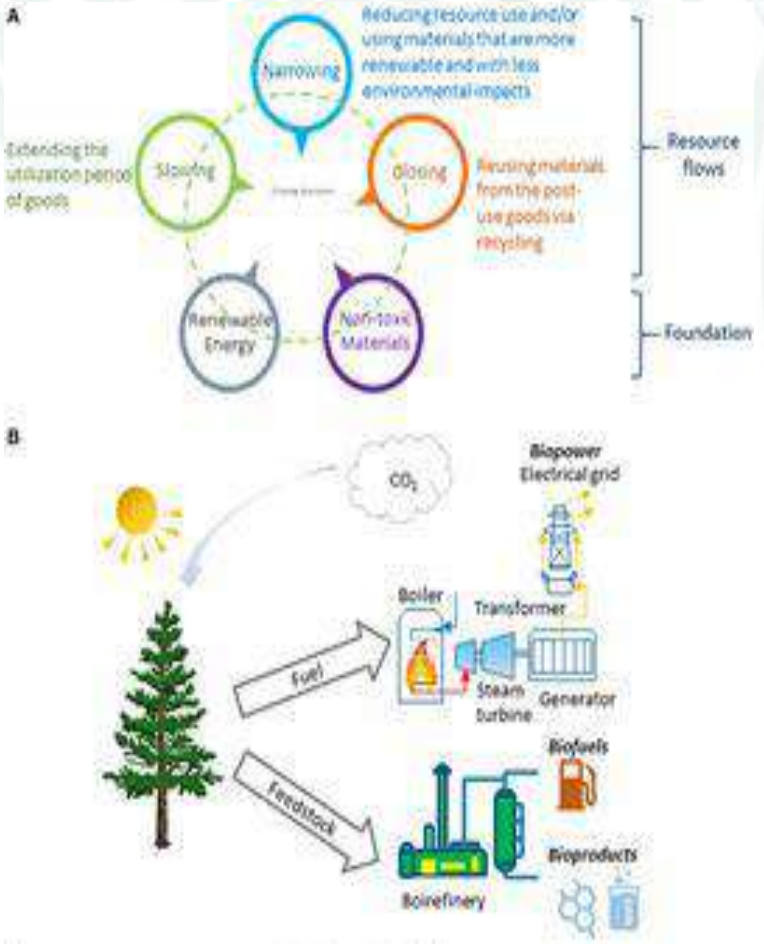
PALM OIL MILL EFFLUENT

CIRCULAR ECONOMY



BIO- CIRCULAR ECONOMY

The bio-based circular carbon economy is **a bioeconomy that focuses on leveraging and exploiting the atmospheric carbon drawdown potential of biomass feedstock to the fullest extent possible**.



Malaysia:
Towards Sustainable Palm Oil

EVALUATE THE COMMON PRACTICES IN THE OIL PALM INDUSTRY AND GAUGE THE GHG EMISSIONS & SAVINGS

GOOD AGRICULTURAL PRACTICES (GAP) TO REDUCE GHG EMISSIONS

- Reduction (optimisation of fertiliser inputs)
- Accumulation of soil carbon in replanting
- Recycling of oil palm biomass
- Implementing zero burning
- Planting of leguminous cover crops
- Integrated Pest Management

OIL PALM BIOMASS

Fertilizer Value

Part of palm	N	P	K	Mg	Ca
Annual pruning	107.9	10.0	139.4	17.2	25.6
Empty bunches	5.4	0.4	35.3	2.7	2.3
Fibre	5.2	1.3	7.6	2.0	1.8
Shell	3.0	0.1	0.8	0.2	0.2
Effluent (raw)	12.9	2.1	26.6	4.7	5.4

Nutrient Content in Biomass Obtained from a ha of Oil Palm (kg/ha/yr)

Fuel properties

Oil Palm Biomass Sample	Calorific Value (CV), Average (MJ/kg)	Moisture Content (%)	Ash Content (%)	Volatile Matter Content (%)	Total Chloride Content (%)
EFB	18.88	66 - 69	4.60	87.0	0.331/0.128*
Mesocarp fibre	19.06	35 - 48	6.10	84.9	0.148/0.113*
Shell	20.09	11 - 13	3.00	83.4	0.157/0.157*
Oil palm frond	15.72	62 - 77	3.37	85.1	0.404/0.250*
Oil palm trunk	17.47	67 - 81	3.35	86.7	0.248/<0.002*
POME	16.99	90 - 95	15.20	77.0	1.956/0.233*

Important Fuel Properties of Various Oil Palm Biomass

RECYCLING/ REUSE OF WASTES BY THE OIL PALM INDUSTRY

EMPTY FRUIT BUNCH

MULCHING
(FERTILISER SUBSTITUTE)
BOILER FUEL
(FOSSIL FUEL SUBSTITUTE)

PRESSED MESOCARP FIBRE

BOILER FUEL
(FOSSIL FUEL SUBSTITUTE)

PALM KERNEL SHELL

BOILER FUEL
(INTERNAL & EXTERNAL)
(FOSSIL FUEL SUBSTITUTE)

BIOGAS – POME

GRID ELECTRICITY/ BOILER FUEL
(FOSSIL FUEL SUBSTITUTE)

EFB MULCHING

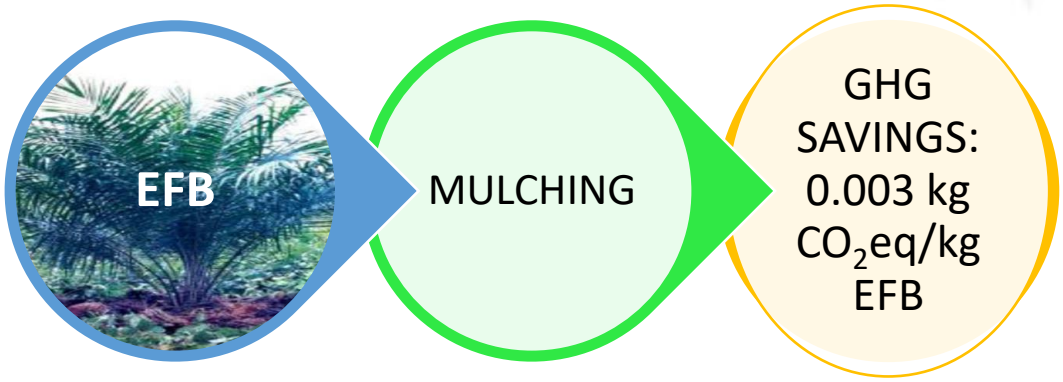
Normal application : 30 – 60t /ha
Reduce production cost

Benefit of Mulching

- Improve soil structure
  - aeration, water holding capacity
- Improve soil pH
- Improve nutrient status
- Root growth and development
- Increase microbial activities
- Reduce leaching
- Improve oil palm growth

GHG SAVINGS FROM THESE PRACTICES

By-product	Empty Fruit Bunch
Utililisation	Mulching
Emission of fertilisers (eco-invent database)	
Urea (kg CO_2eq/t)	3.16
Rock Phosphate (kg CO_2eq/t)	70.91
Muriate of Phosphate (kg CO_2eq/t)	0.53
Displacement (Menon et al., 2003)	Inorganic fertilisers
Urea (kg /t FFB)	0.69
Rock Phosphate (kg/t FFB)	0.1
Muriate of Phosphate (kg/t FFB)	2.76
Kieserite (kg/t FFB)	0.46
GHG savings from the production of the fertilisers Urea, Rock Phosphate, Muriate of Phosphate (kg CO_2eq/t FFB)	0.01
GHG savings from the application of the fertilisers Urea, Rock Phosphate, Muriate of Phosphate (kg CO_2eq/t FFB)	1.36
Emission factor of Diesel (kg CO_2eq /L) (Azeez, 2016)	2.68
GHG emissions for transporting Empty Fruit Bunch (kg CO_2eq/ t FFB)	0.62
GHG savings (kg CO_2eq/t FFB)	0.75
GHG savings (kg CO_2eq/t EFB)	3.26
GHG savings (kg CO_2eq/kg EFB)	0.003



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USE OF BIOMASS IN THE BOILERS AT THE PALM OIL MILL

PALM KERNEL SHELL

CV: 20 MJ/kg
MC: 12 %
Displaces : 3.6kWh/ t PKS

PRESSED MESOCARP FIBRE

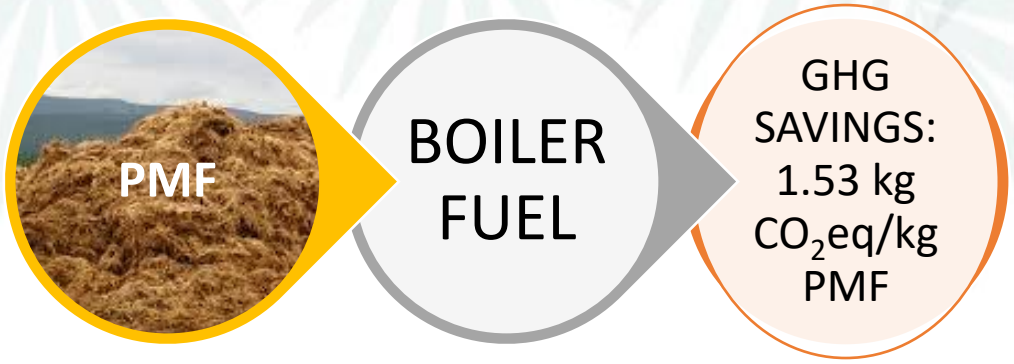
CV: 19 MJ/kg
MC: 37 %
Displaces : 2.5kWh/ t PMF

EMPTY FRUIT BUNCH

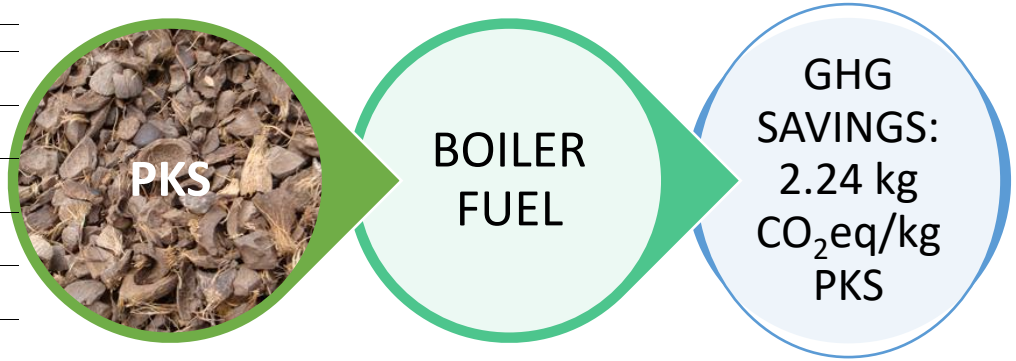
CV: 18.88 MJ/kg
MC: 67 %
Displaces : 2.0kWh/ t EFB

GHG SAVINGS FROM THESE PRACTICES

By-product	Pressed Mesocarp fibre (PMF)
Utililisation	Boiler fuel
Displacement	Grid connected electricity (Fossil fuel)
Net Calorific value (MJ/kg) (Loh, 2017)	19.0
Moisture content (MC) (%) (Loh, 2017)	37.00
Gross calorific value @ 37% MC (MJ/kg)	11.97
Conversion factor (MJ to kWh) (Unit conversion calculator, 2020)	0.2778
Potential electricity that can be generated by PMF @75% boiler efficiency (kWh/kg)	2.49
Pre- treatment of biomass	-
Average emission factor of electricity production in Malaysia ($kgCO_2eq/kWh$) (SEDA, 2020)	0.615
GHG savings (kg CO_2eq/kg PMF)	1.53

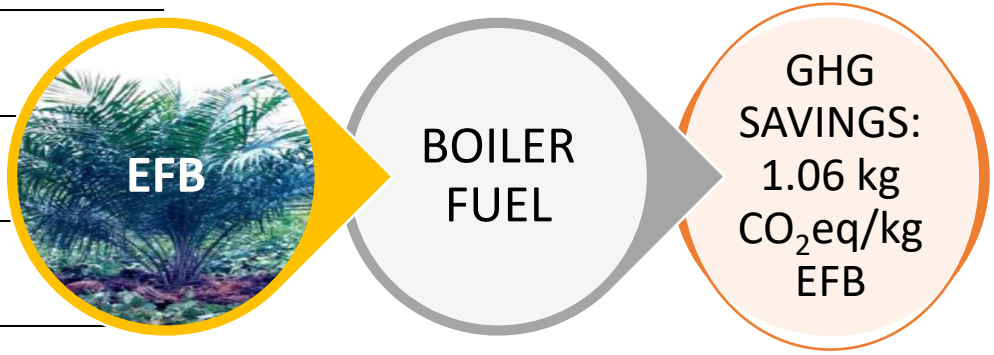


By-product	Palm Kernel Shell (PKS)
Utililisation	Boiler fuel
Displacement	Grid connected electricity (Fossil fuel)
Net Calorific value (MJ/kg) (Loh, 2017)	20.00
Moisture content (MC) (%) (Loh, 2017)	12.00
Gross calorific value @ 12% MC (MJ/kg)	17.60
Conversion factor (MJ to kWh) (Unit conversion calculator, 2020)	0.2778
Potential electricity that can be generated by PKS @ 75% boiler efficiency (kWh/kg)	3.67
Pre- treatment of biomass Electricity required for pre-treatment (kWh/kg PKS)	-
Average emission factor of electricity production in Malaysia ($kgCO_2eq/kWh$) (SEDA, 2020)	0.615
Emission factor of Diesel (kg CO_2eq /L) (Azeez, 2016)	2.68
GHG emissions for transportation of PKS to outside boilers in Malaysia (kg CO_2eq/kg PKS)	0.0055
GHG savings used in outside boilers (kg CO_2eq/kg PKS)	2.24



GHG SAVINGS FROM THESE PRACTICES

By-product	Empty Fruit Bunch
Utililisation	Boiler fuel
Displacement	Grid -connected electricity (Fossil fuel)
Net Calorific value (MJ/kg) (Loh, 2017)	18.88
Moisture content (MC) (%) (Loh, 2017)	65.00
Gross calorific value @ 50% MC (MJ/ kg)	9.44
Conversion factor (MJ to kWh) (Unit conversion calculator, 2020)	0.2778
Potential electricity that can be generated by EFB @75% boiler efficiency (kWh/kg)	1.96
Electricity required for pre-treatment (kWh/ kg EFB)	0.25
Average emission factor of electricity production in Malaysia ($kgCO_2eq/kWh$) (SEDA, 2020)	0.615
GHG emissions for pre-treatment of EFB ($kg\ CO_2eq/\ kg$ EFB)	0.15
GHG savings ($kg\ CO_2eq/kg$ EFB)	1.06



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BIOGAS – POME

GRID ELECTRICITY/ BOILER FUEL
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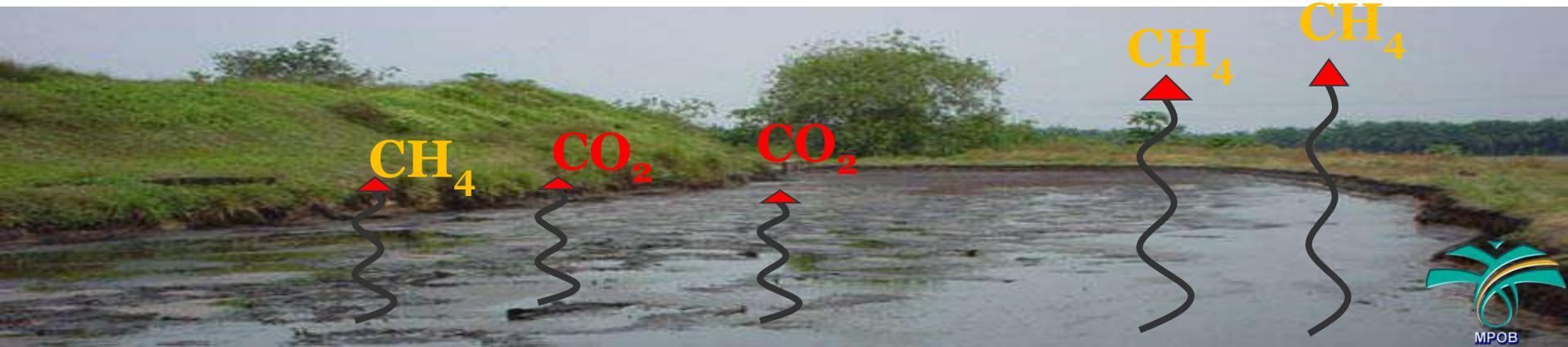
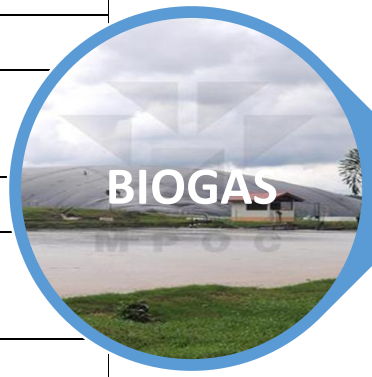
BIOGAS CAPTURE

- About 0.65 t of POME is generated for every 1 tonne of FFB processed
- 65 million tonnes of POME generated in 2015
- It contains about 60-70 % Methane (CH_4), 30-40 % Carbon Dioxide (CO_2) and trace amount of Hydrogen Sulphide, (H_2S)
- Methane - a greenhouse gas (GHG), the global warming potential – 25 times higher than CO_2
- Potential yield: 1 m^3 of completely digested POME produces 28 -38 m^3 biogas



GHG SAVINGS FROM THESE PRACTICES

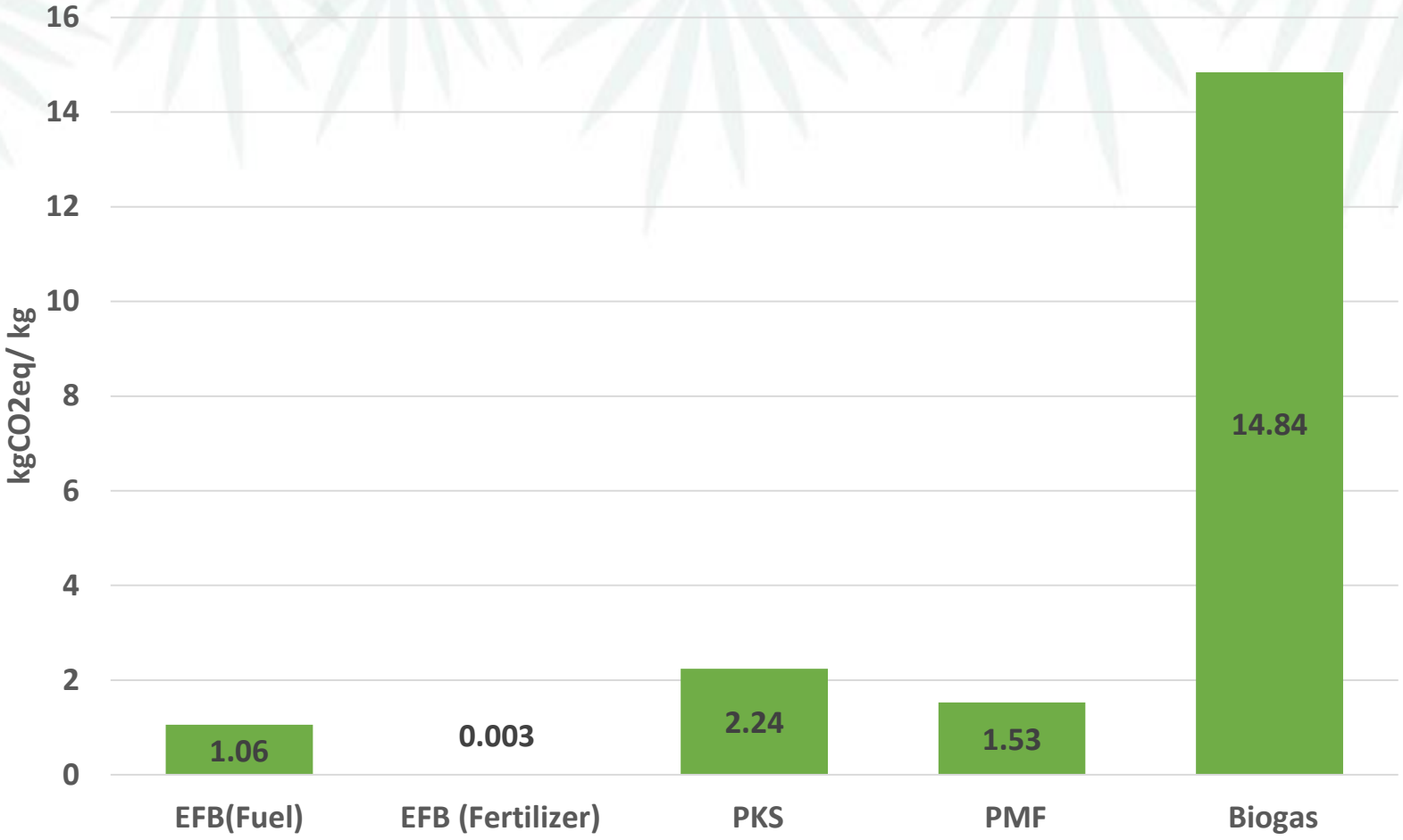
By-product	Biogas from POME
Utililisation	Boiler fuel
Displacement	Grid connected electricity (Fossil fuel)
Heat value (MJ/m^3 biogas) (Loh, 2017)	20.00
Potential electricity that can be generated by biogas @ 50% utilization factor (kWh/m^3 biogas)	2.78
Methane correction factor (assumption)	0.80
Pre-treatment of biomass	-
Average emission factor of electricity production in Malaysia ($kgCO_2eq/kWh$) (SEDA, 2020)	0.615
Density of biogas (kg/m^3) (Ma, 1999)	0.900
GHG savings for biogas capture (95% capture efficiency) (kg CO_2eq/ m^3 biogas)	11.65
GHG savings by utilization of biogas as electricity (kg CO_2eq/ m^3 biogas)	1.71
Total GHG savings (kg CO_2eq/m^3 biogas)	13.36
Total GHG savings (kg CO_2eq/kg biogas)	14.84



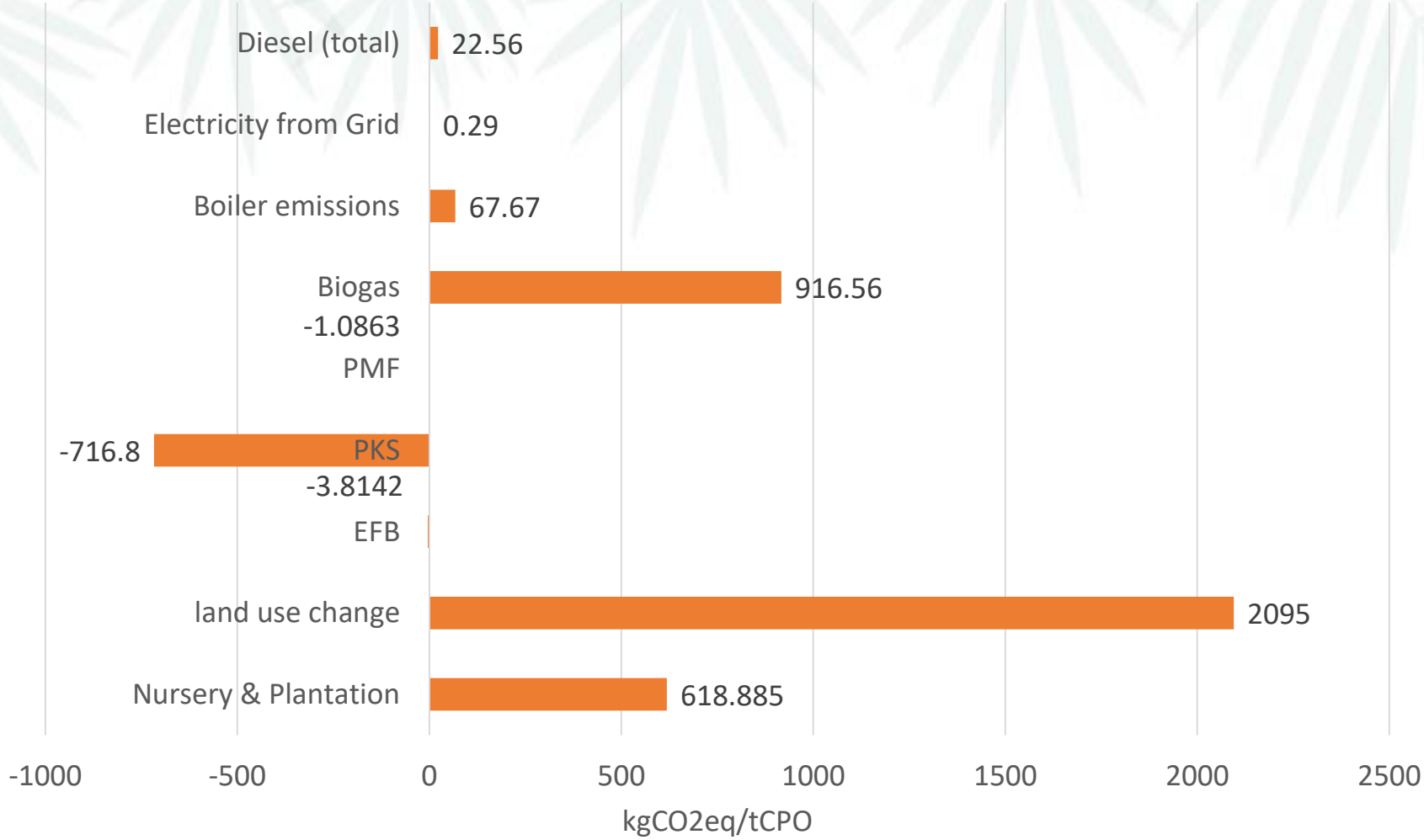
GRID ELECTRICITY/ BOILER FUEL

GHG SAVINGS: 14.8 kg CO_2eq/kg BIOGAS

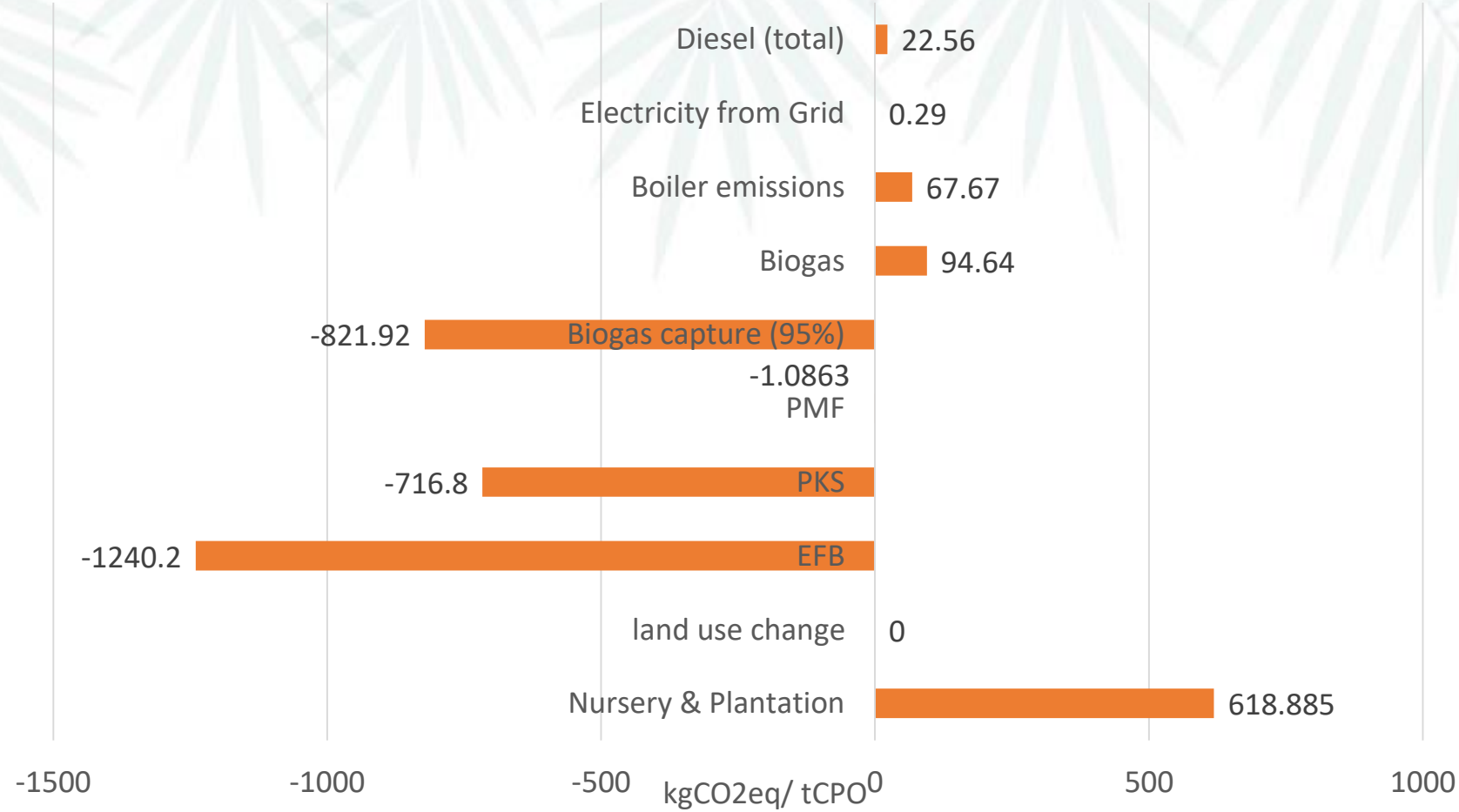
GHG SAVINGS FROM THESE PRACTICES



GHG EMISSIONS & SAVINGS



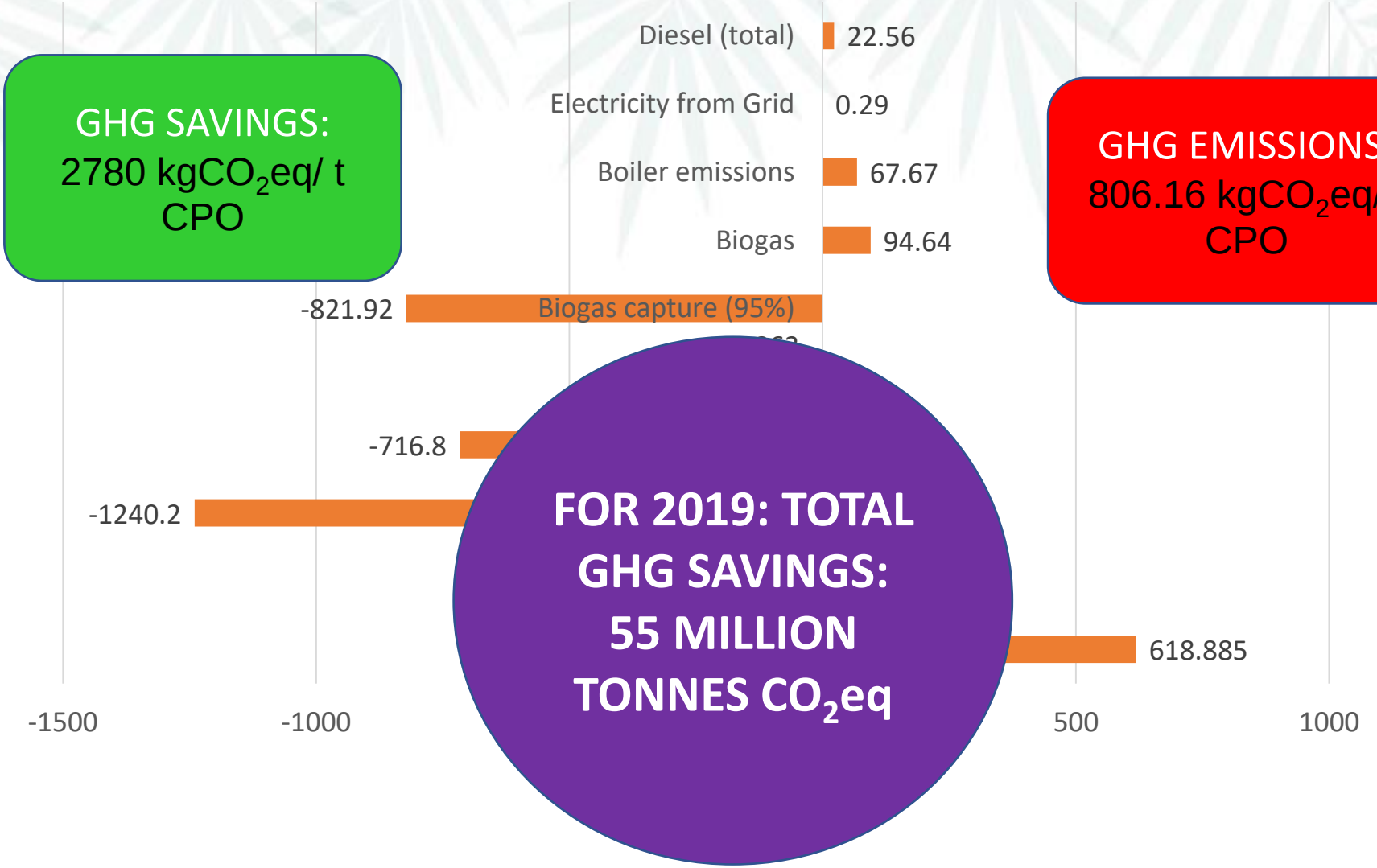
GHG EMISSIONS & SAVINGS - BEST PRACTICES PATHWAY



GHG EMISSIONS & SAVINGS - BEST PRACTICES PATHWAY

GHG SAVINGS:
2780 $kgCO_2eq$/ t CPO

GHG EMISSIONS:
806.16 $kgCO_2eq$/ t CPO



FOR 2019: TOTAL GHG SAVINGS: 55 MILLION TONNES CO_2eq

CONCLUSIONS

These practices are being carried out by the industry.

Towards achieving bio-circular economy.

GHG reductions.

Contributes towards reduction - Climate Change and Global Warming.

THANK YOU