Biofuels: Facts, figures and current scenario

CGPL, Bangalore

March 24, 2006

Udipi Shrinivasa

SuTRA

Department of Mechanical Engineering

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Contents

- Current Scenario – International
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- Need and potential in India
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Biofuels: Current Scenario

International

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Biofuels: Current Scenario

The largest ever liquid biofuel (vegetable oil) power plant based on Wartsila 18 V32 engines will be producing 24 MWe of ‘green electricity’ in the very active Italian energy market

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Biofuels: Current Scenario International

USA

5% blending in diesel since 2002

1 USD tax credit per gallon blended since November 2004

Castor Harley in California as a resource

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Biofuels: Current Scenario International

G8 countries

International Workshop on Bio-energy
Department of Environmental Research & Development
Italy, Rome
June 14 &15, 2005

White paper

Go green with SuTRA

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Biofuels: Current Scenario International

Denmark and Netherlands

- PPO for cars
- Plans to generate power from animal tallow and chicken fat
- Govt policy to evolve

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Acceptability

Germany versus France

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Biofuels: Current Scenario International

Sourcing of oil

D1 oils

13 million pounds from market

Diligent Energy Systems

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Biofuels: Current Scenario International

Sourcing of oil

Australia : ABA

ARF + ABF + Others

Biofuels: Current Scenario International

Tanzania

Uganda

Columbia

Thailand

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Mali

Nicaragua

Zimbabwe

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Biofuels: Current Scenario International

Summary:

- Enthusiasm and emotional support
- Lack of clarity
- Re-colonisation ?
- Recognised investment option

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Biofuels: Current scenario

India

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Biofuels: Current Scenario India

In Bangalore

Oil is cheaper

than diesel

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Biofuels: Current Scenario India

Press release

Tuesday, June 07, 2005

PETROLEUM

BIO-DIESEL – ALTERNATIVE ENERGY SOURCE

R.C. Joshi*

13:47 IST

The largest resource liability for India lies in its inputs of Petroleum products. They are essential to maintain the tempo of the high growth rate of the Indian economy. India today consume about 111 million tonnes of petroleum products annually. Of this, only about 33 million tonnes is produced in the country as crude oil thereby implying that less than 30 per cent of the needs are met from domestic sources. The ratio is likely to further aggravated as the fuel needs would increase along a higher trajectory as the Indian economy is project to growat about 8 per cent per annum. Import dependence is estimated to go up to 85 per cent by 2020. Conversely, even the worsening self sufficiency ratio for oil is not as bad as the availability of hydrocarbon is critical to maintaining high growth rate.

Biofuels: Current Scenario - India

Times of India: July 1, 2005

Diesel grows on trees

Fuel does grow on trees

By LEENA MEHENDALE and RANJAN GOSWAMI

The burning of fossil fuels at the current rate is likely to create an environmental crisis. In India, bio-diesel, an alternative and renewable source of energy, is gaining momentum. Bio-diesel burns cleaner and is available from natural, renewable sources such as tree-borne oilseed and animal fats. Like petroleum diesel, bio-diesel operates in compression and ignition engines.

Blends of up to 20% bio-diesel (mixed with petroleum diesel) can be used in nearly all diesel and most storage and distribution equipment. These low-level blends (20% and less) generally do not require any engine modifications. Bio-diesel can provide the same payload capacity as diesel.

India consumes about nine million tonnes of petrol and 42 million tonnes of diesel, the crude import bill in the region of Rs 1,10,000 crore. A blend of ethanol in petrol and bio-diesel in diesel will, therefore, make a big difference both in our import bill as well as in the environmental impact. Bio-diesel has 10% built-in oxygen and properties that would help it burn efficiently, which would, in turn, lead to less use of fossil fuel. As a tree-based source, it would mitigate the greenhouse effect.

Jatropha curcas has been identified for India as the most suitable tree-borne oilseed for production of bio-diesel, in view of the non-edible oil available from it and its presence throughout the country. The capacity of jatropha curcas to rehabilitate degraded lands by improving the land's water retention capacity renders it suitable for upgradation of land resources. This oil needs to be converted to bio-diesel through a simple chemical process called trans-esterification. While large plants would be useful for centralised production, smaller plants can also be started at the village level.

Jatropha plantation on wasteland can rebuild our afforestation programme. One plant of jatropha can offset 0.15 tonne of carbon dioxide per year. Assuming the presence of 200 plants in a hectare, a lakh hectares of wasteland planted with jatropha can fetch 27 million carbon credit points for the country.

The current annual petro-diesel consumption in the country is 40 million tonnes. For blending 5% bio-diesel in petro-diesel, India needs around two million tonnes of bio-diesel annually. By January 2006, India's demand for petro diesel will touch 52 million tonnes. For 5% blend bio-diesel, we will need 26 lakh tonnes of bio-diesel. The land area required for jatropha plantation would be 2.5 million hectares. If we can further increase the use of bio-diesel to 20%, the figures projected for January 2011 are 67 million tonnes of petro-diesel, 134 lakh tonnes of bio-diesel and 13 million hectares of land.

We need to push bio-diesel in the market. The use of bio-diesel is hampered by ad hoc production and high cost that lowers demand. If we ensure steady flow of demand, it would build up sustained production and supply and bring down the cost. Farmers are not encouraged to grow jatropha when the demand for bio-diesel is low. The vicious cycle of high price leading to low demand and non-establishment of a supply chain, which in turn results in high prices, can be broken by an assurance of steady purchase by the government, especially oil companies.

Initial incentives have been given to promote green fuels through various methods. It is proposed that a limited subsidy be given on a reducing scale for a limited period. This would help in establishing supply chains quickly.

The proposed model of subsidy envisages the purchase of bio-diesel at a landed price of Rs 40 per litre for the first six months, then Rs 35 for next six months and Rs 30 for another six. Thereafter, it may be purchased at a minimum support price of Rs 25 per litre.

The Petroleum Conservation Research Association (PCRA) has already established a national biofuel centre, with a strong website meant to work as an information bank. PCRA has developed institutional linkages for research and development in the field of biofuels with Indian Oil Corporation, Delhi College of Engineering and other R&D Institutes.

What is required now is to propagate bio-diesel as a viable crop to farmers and as a viable fuel to auto users.

The writers are with PCRA.

Biofuels: Current Scenario India

Activities in states

Maharashtra

Tamil Nadu

Andhra Pradesh

Karnataka

CG

Railways

NTPC

KSRTC

Elsewhere

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Biodiesel plants

Business houses

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Biofuels: Current Scenario India

First IPO

Southern Bio-technologies Limited

బయోడీజిల్‌తో నడిచే ఆర్టీసీ వాహనానికి ఆదివారం పచ్చజెండా ఊపి ప్రారంభిస్తున్న ముఖ్యమంత్రి వైఎస్.రాజశేఖరరెడ్డి.

ANDHRA JYOTHI DT. 6.06.2005

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Biofuels: Current Scenario India

Summary

Sporadic activities

Policy about to come

Enthusiasm is growing

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Biofuels: Current Scenario - India

President Kalam's mantra for national prosperity

January 25, 2005 17:49 IST

Last Updated: January 25, 2005 20:16 IST

This is the complete text of* President A P J Abdul Kalam's *address to the nation on the eve of the country's 56th Republic Day:

Bio-Fuel Generation

We have nearly 63 million hectares of wasteland available in the country, out of which 33 million hectares have been allotted for tree plantation. Certain multi-purpose bio-fuel plants can grow well in wastelands with very minimum input. Once cultivated, the crop has fifty years of life. Fruiting can take place in two years.

Bio-fuel plants grown in parts of wastelands, for example, 11 million hectares can yield a revenue of approximately Rs. 20,000 crore a year and provide employment to over 12 million people both for plantation and running of extraction plants. It will reduce foreign exchange outflow for import of crude oil, cost of which is continuously rising in the international market. Bio-fuel is Carbon mono-oxide emission free. The oil can also be used for soap and in the candle industry. De-oiled cake is a raw material for composting and the plantation is also good for honey production. We should absorb the best of technologies available worldwide and start commercial operations immediately. One time investment needed for bio-fuel plantation to production in 11 million hectares will be approximately Rs. 27,000 crore. Capital equipment and investment in plant and machinery can come from bank loans and private sector entrepreneurs. I have seen the progress in bio-fuel plant cultivation, preparation of seedlings, tissue culture and development of non-toxic hybrid varieties in the Tamil Nadu Agricultural University in Coimbatore. They have also worked from processing of seeds to bio-fuel production by indigenous design and development of bio-fuel plants. Anand Agriculture University at Anand in Gujarat has also made progress in bio-fuel cultivation and processing in Gujarat. Bio-fuel plants can be grown in a number of states in the Southern, Western and Central parts of the country.

India

Need and Potential

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Our rural poverty

- 100 million farming house holds
- 3 months of agriculture
- 16% of the potential wage days
- 200 million jobs required
- All the jobs in the USA and Europe **are not enough**!

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Our resources – what we have

- Potential of the land to quadruple the output
- Adequate precipitation
- Available technologies

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Our resources – what we need!

- Adequate energy resources
- Choice of crops
- Necessity for new alternatives

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Land, water and energy

- 57% arable land
- Monsoon crop
- 400% increase

- 1000 mm rainfall
- Collect and store rain water
- Distribute efficiently

- ~5 kWh/m^2/day solar energy
- Collect and store
- Use for irrigation

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Water package (hardware)

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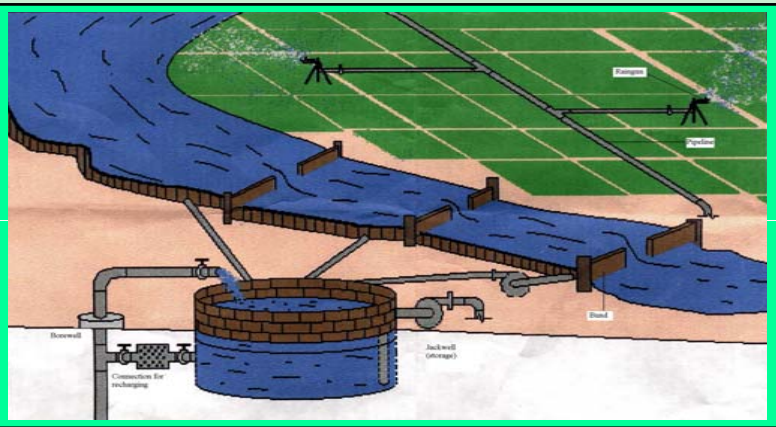
Sustainable water package



- Distribution to land from jack-well
- Fill jack-well from bunds until dry season

- Fill jack-well from bore-wells in summer
- Recharge bore-wells from jack-well in the next season

Water for land use is sustainable

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What will we grow?

Use land for	Use labour for
• More food? No • More fruits? No • More vegetables? No • More sugarcane? No	• More food? No • More fruits? No • More vegetables? No • More sugarcane? No
To use existing land • Candidate crops	To use more labour • Energy and capital for mechanization

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A new possibility!

- Perennial oilseed crops
- Solar energy harvest
- Seed philosophy
- Oils as good as petro-fuels

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Why Biofuels?

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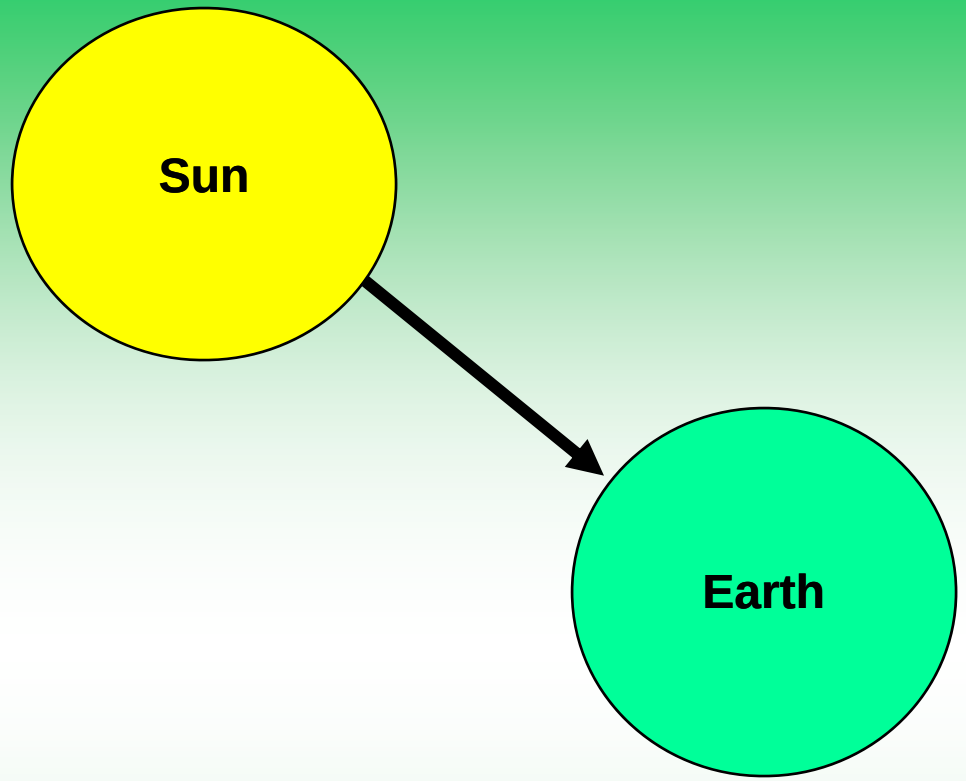

Energy received from the sun in 1 day > 100 times the energy consumed by all countries in a year

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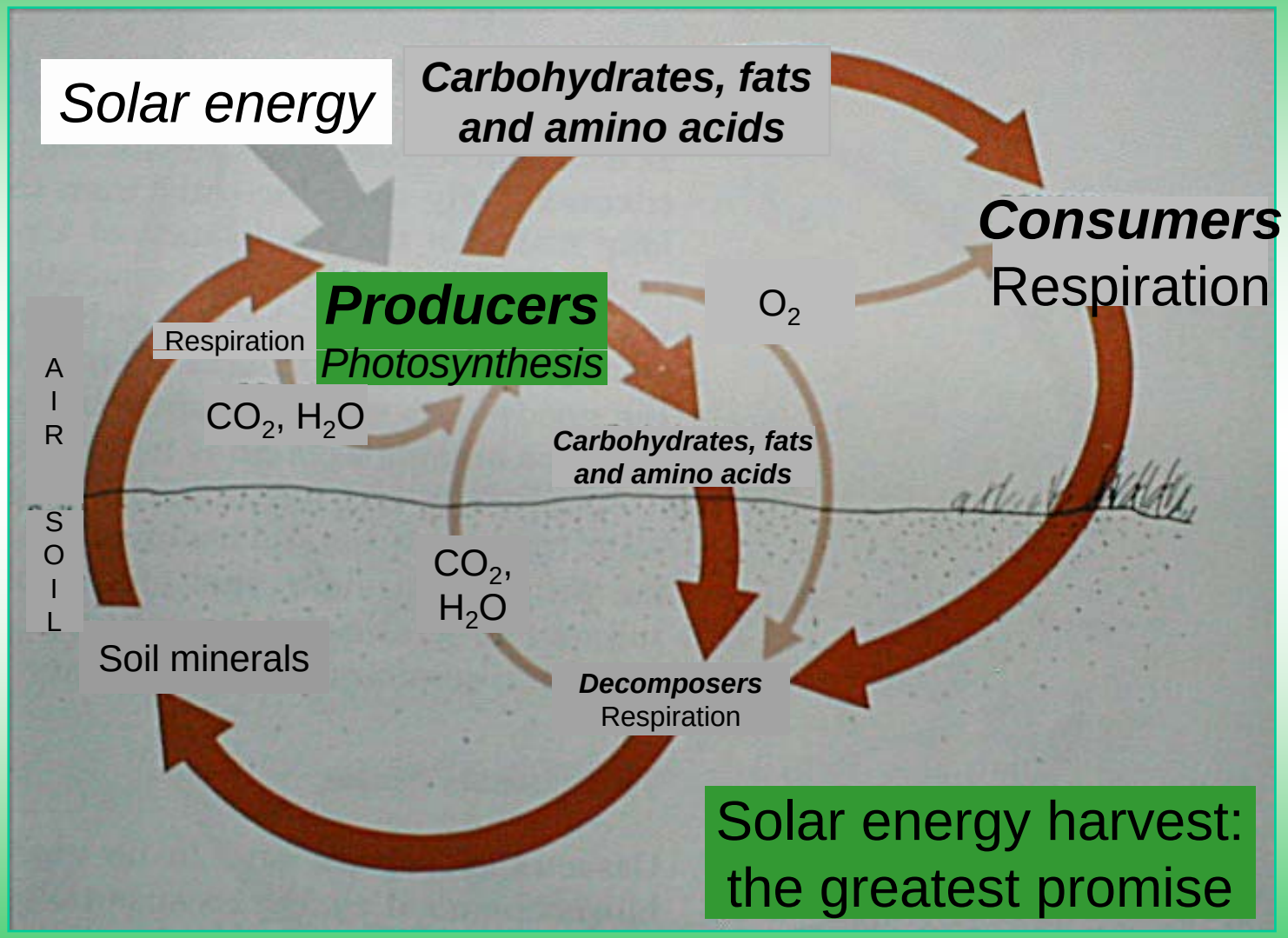
The circles of life



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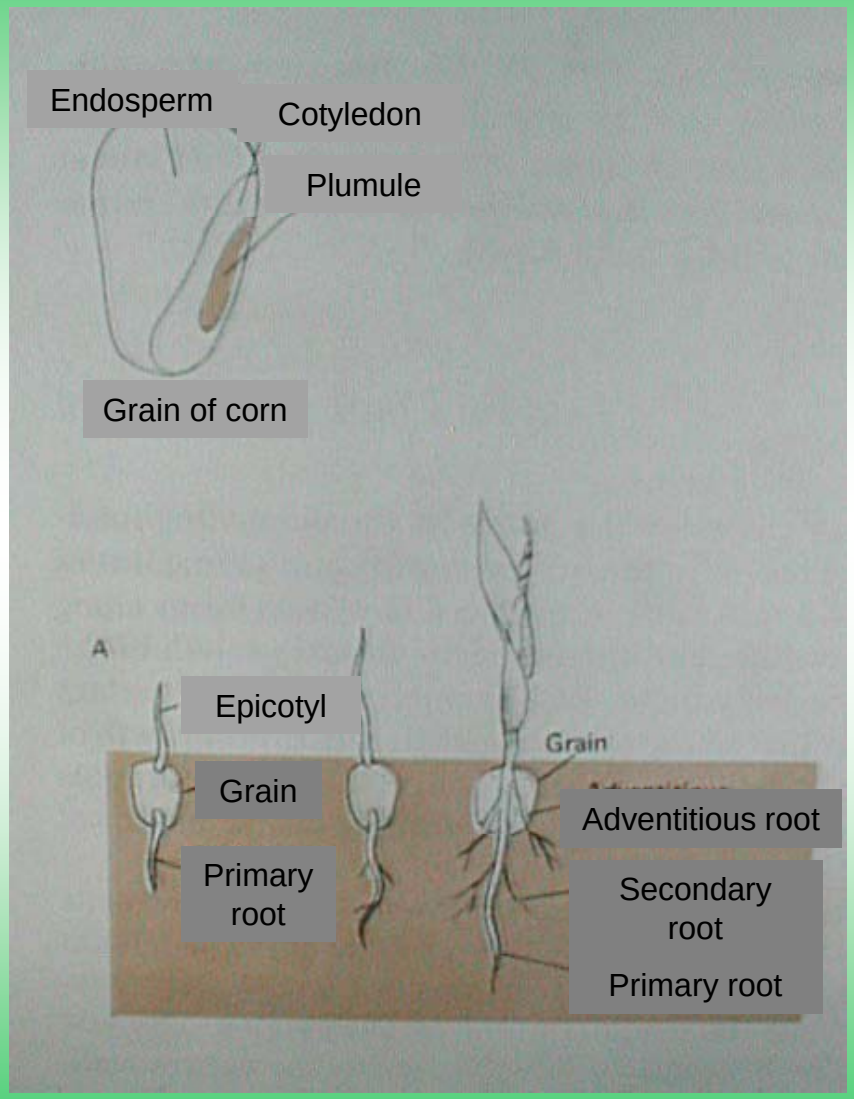
Nature’s energy capsules



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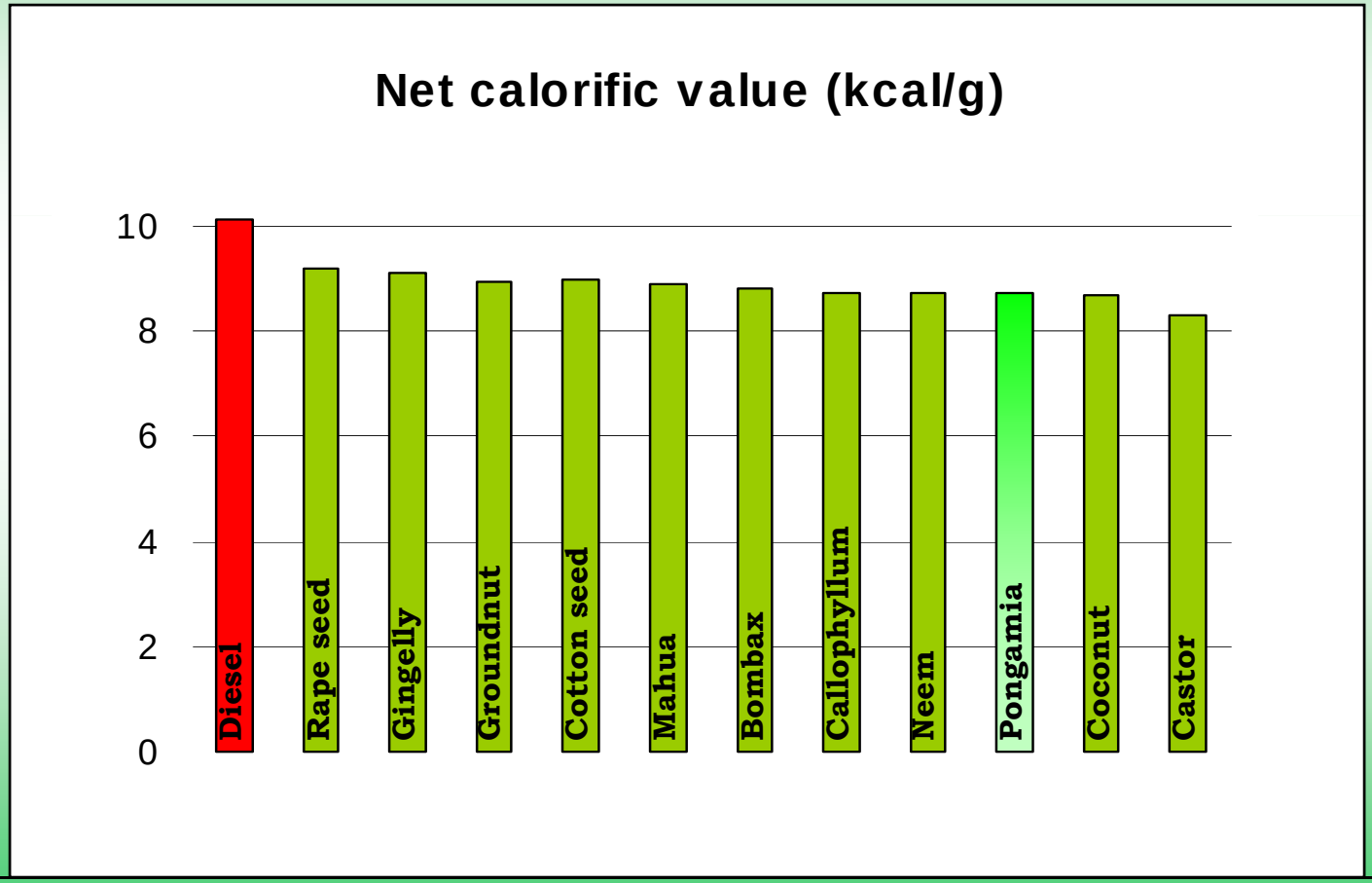
Biofuels are as good as petro-diesel



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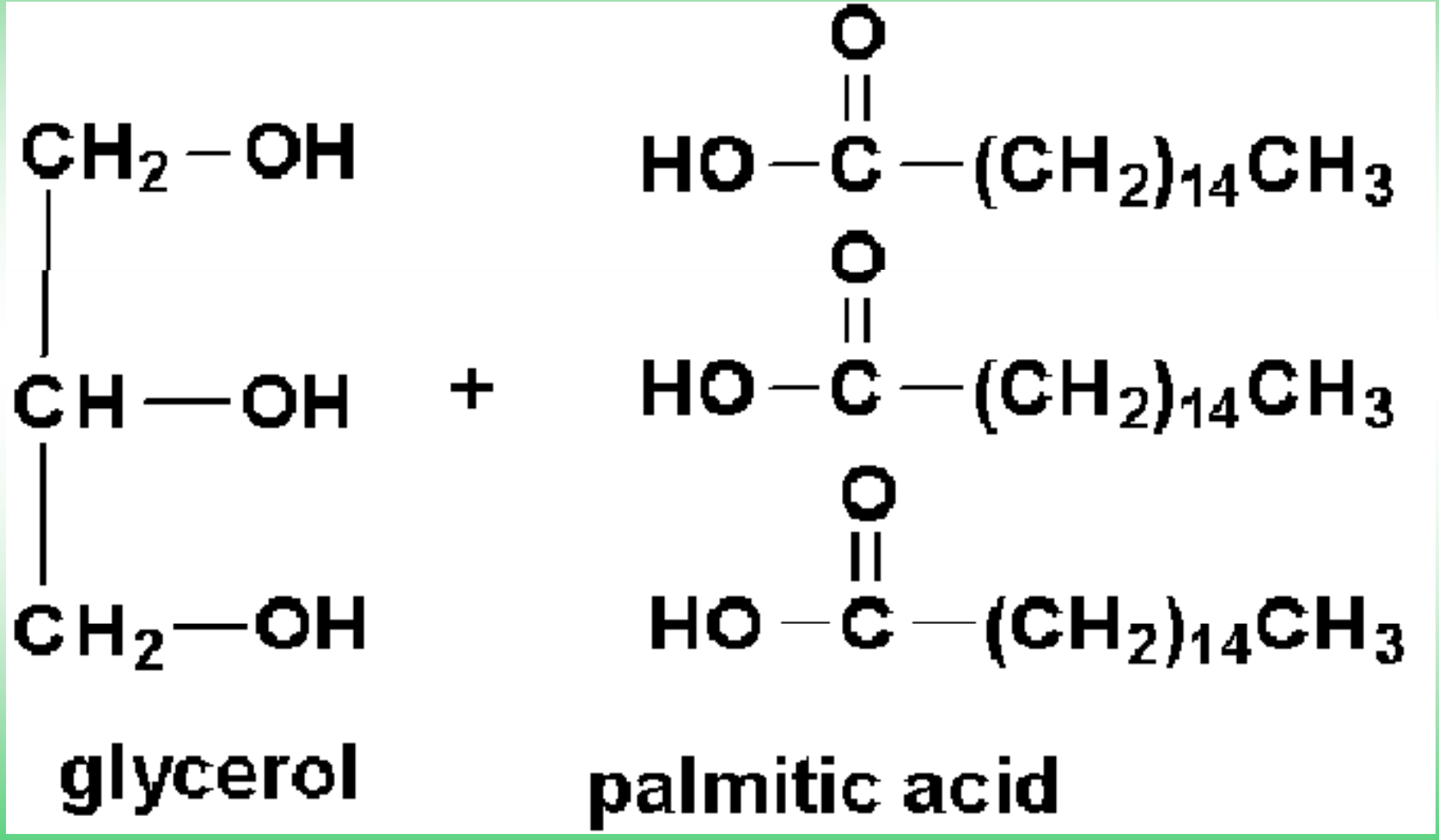
Triglycerides



Common Fatty Acids

Formula	Common Name	Melting Point
16:0	palmitic	63.1°C
18:0	stearic	69.1°C
18:1	oleic	13.2°C
18:2	linoleic	-9°C
18:3	linolenic	-17°C
20:4	arachidonic	-49.5°C

longer side chain increases the melting point

double bonds decrease the melting point

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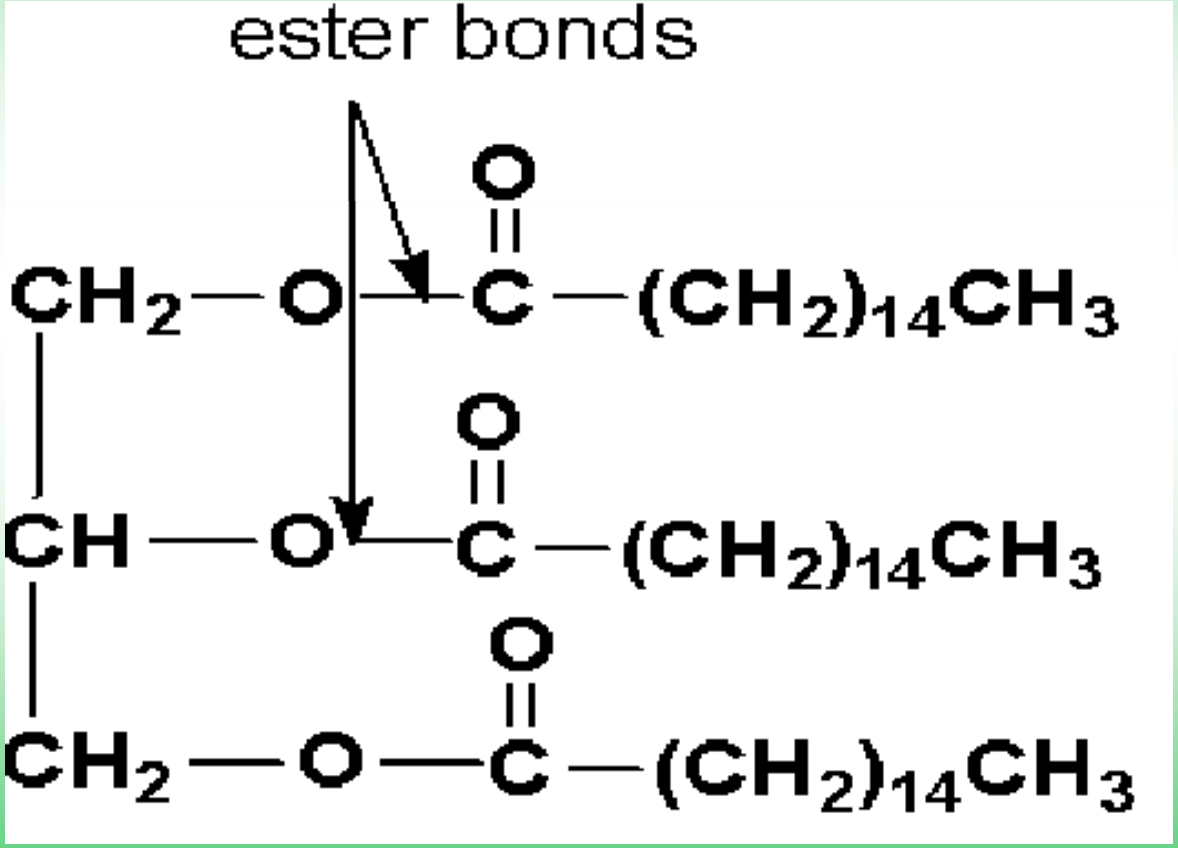
Transesterification



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Requirements for Biodiesel (B100)[A]

Property	Limits	(Honge)	Units
Flash point (closed up)	100.0 min	205	^{O} C
Water and sediment	0.050 max	?	% volume
Kinematic viscosity	1.9-6.0 mm^2/s	44	at 40^{o}C
Sulfated ash	0.020 max	?	% mass
Sulfur	0.05 max	-	% mass
Copper strip corrosion	No. 3 max	?	
Cetane number	40 min		
Cloud point	Report to customer		^{o} C
Carbon residue	0.050 max	.42	% mass
Acid number	0.80 max	5.6	mg KOH/g
Free glycerin	0.020	-	% mass
Total glycerin	0.240		% mass

Percentage composition

	Diesel	Karanj
Carbon	86.9	76.9
Hydrogen	12.4	11.3
Oxygen	0.7	11.8
H/C Ratio	0.14	0.15

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Limitations

Flash point ≈ 230^{o}C

Non boiling

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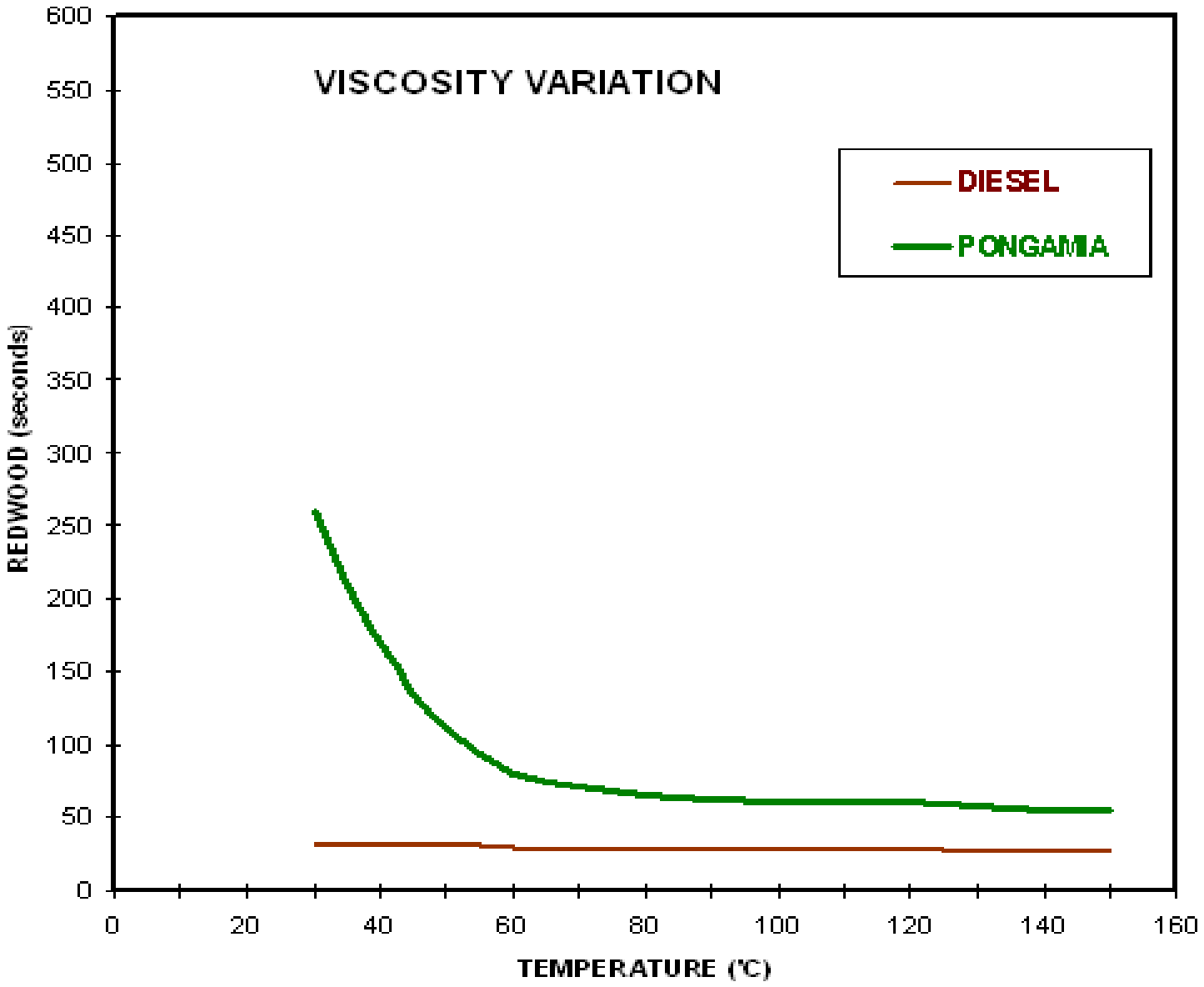

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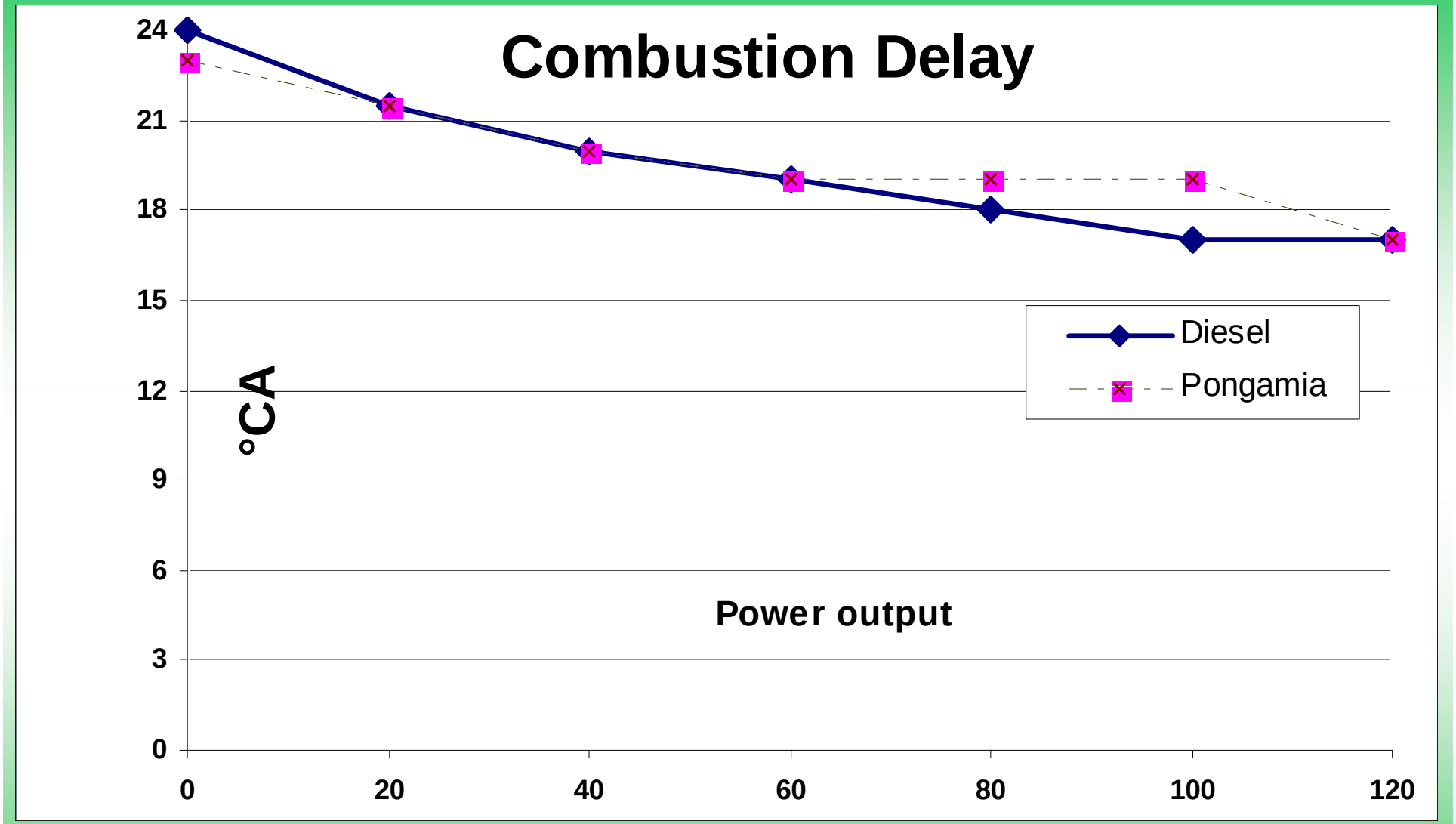

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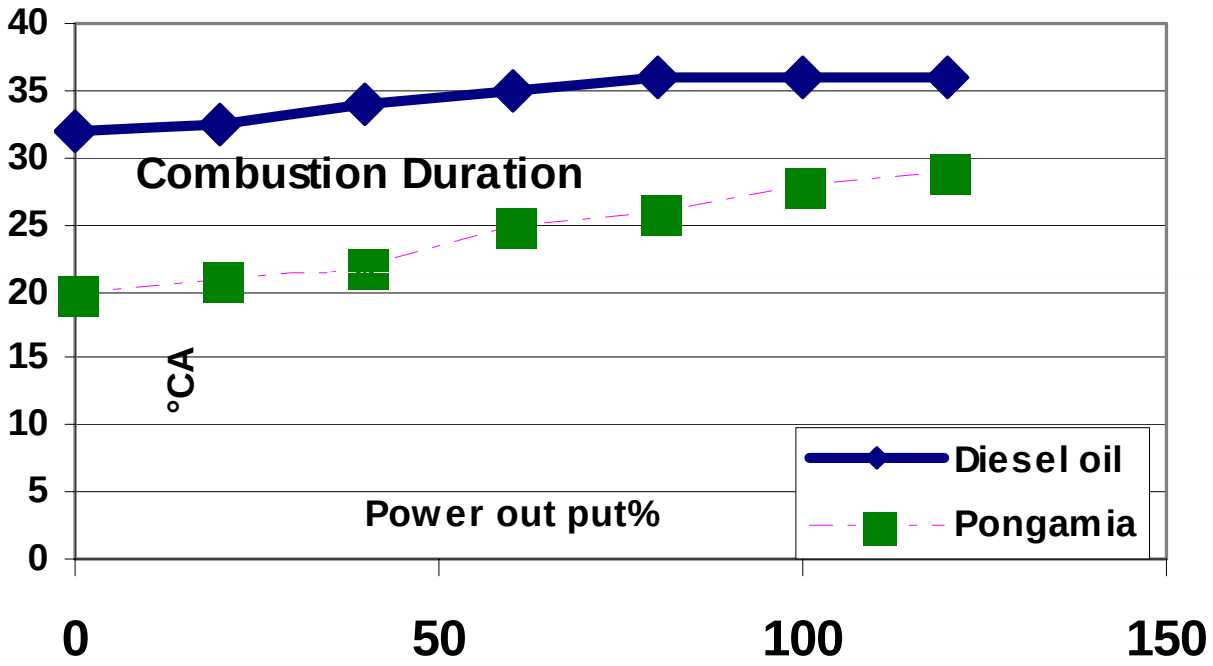
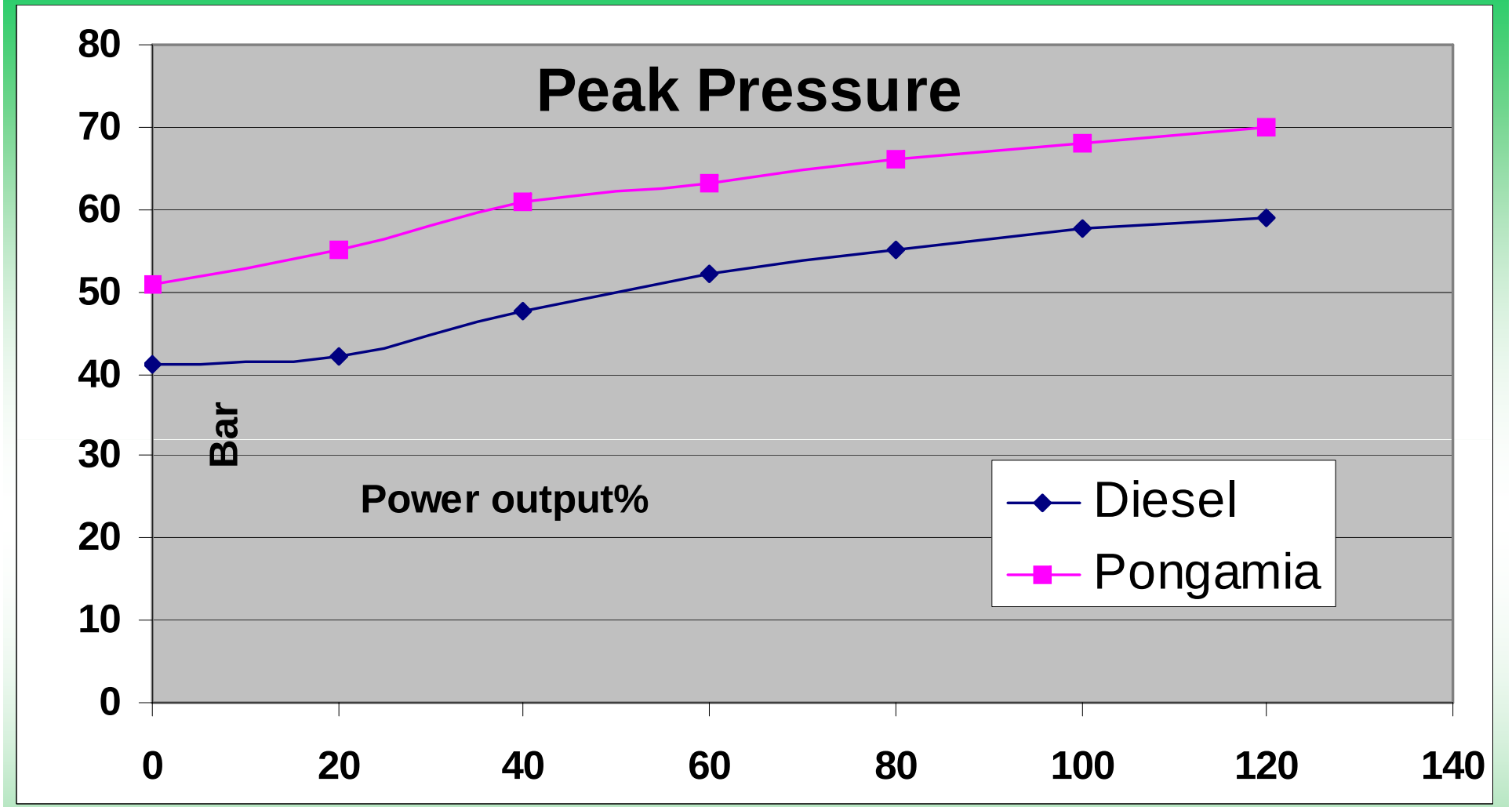

40
35
30
25
20
15
10
5
0
Combustion Duration
°CA
Power out put%
Diesel oil
Pongamia
0
50
100
150



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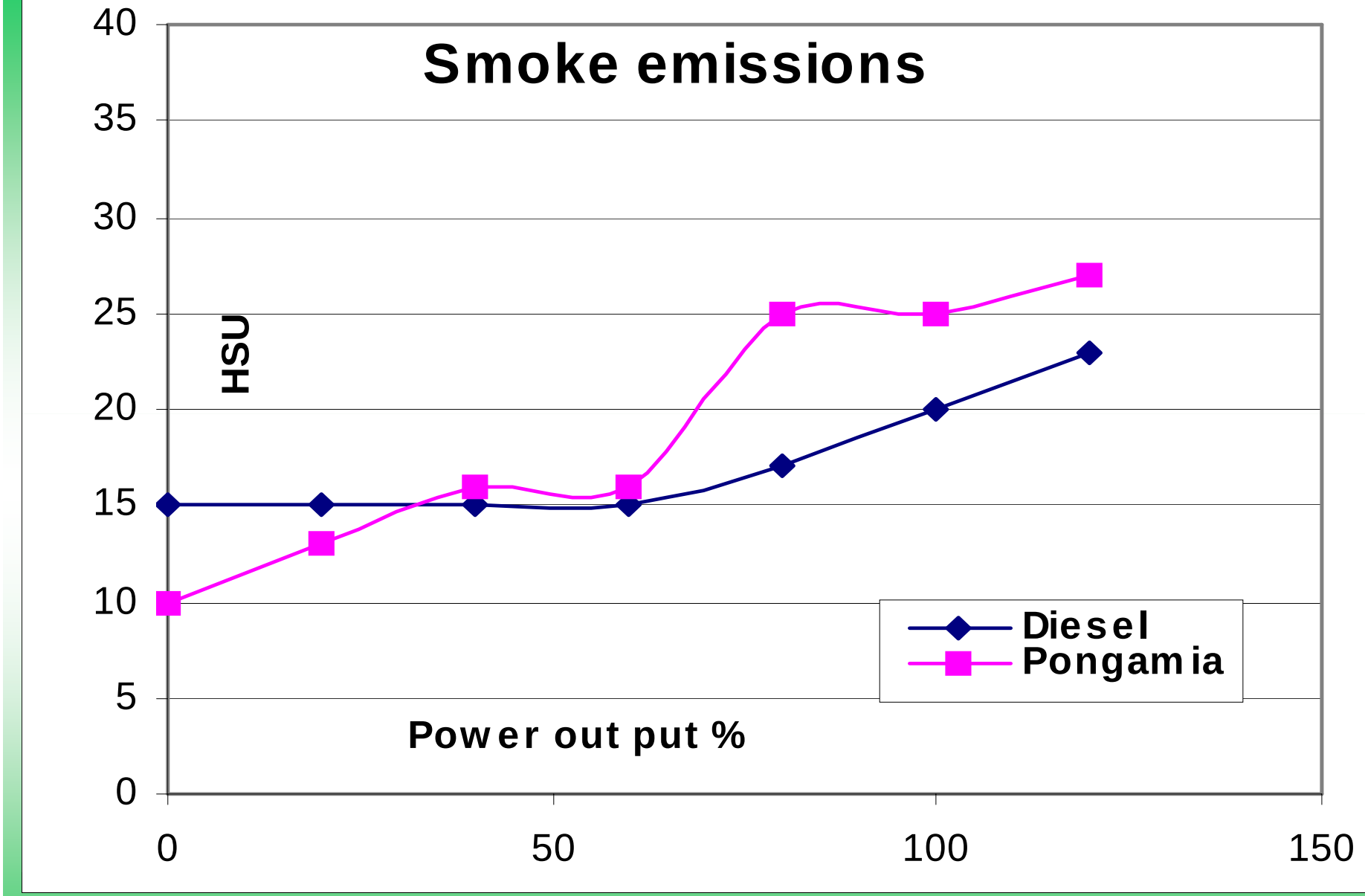

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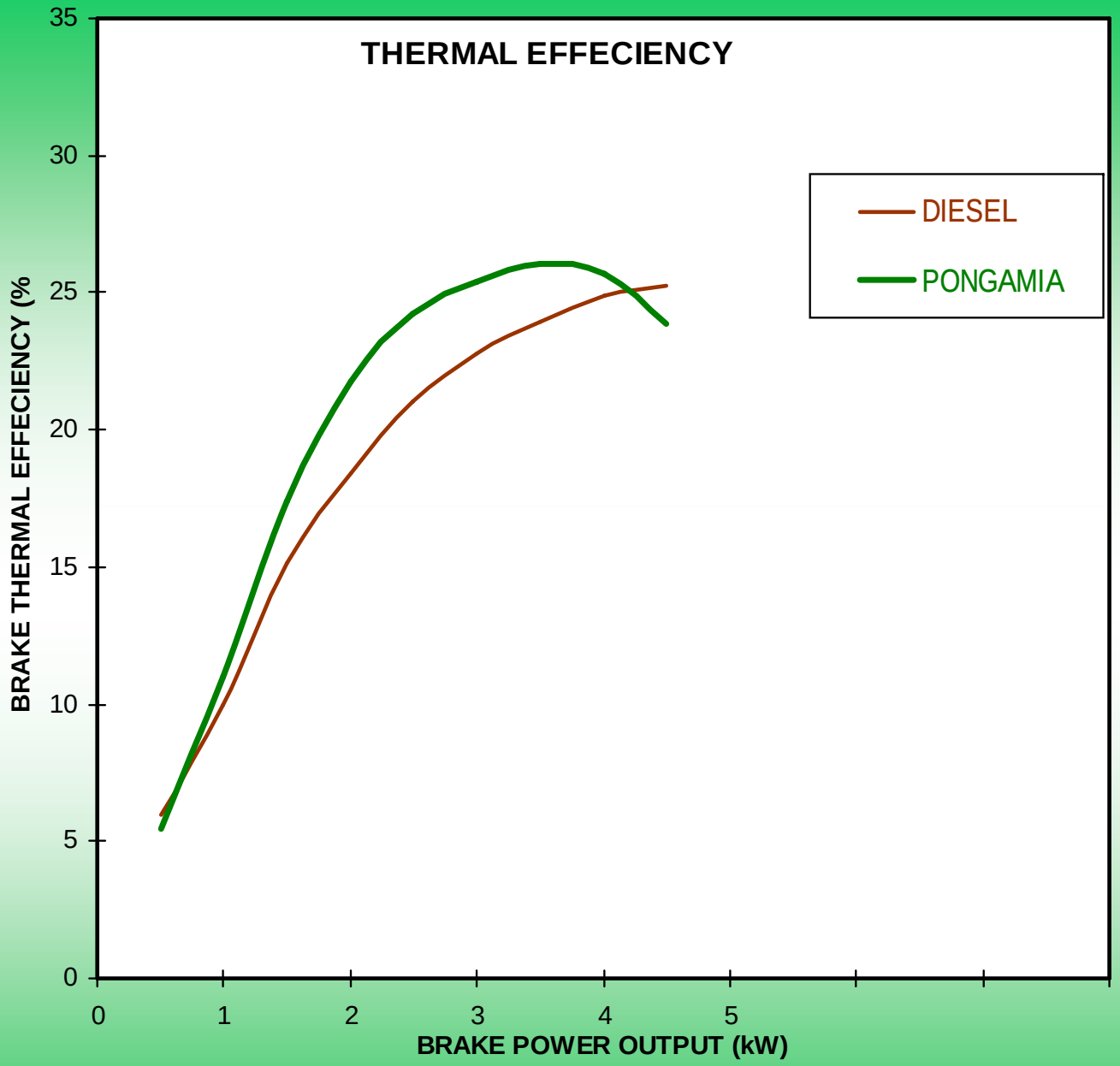

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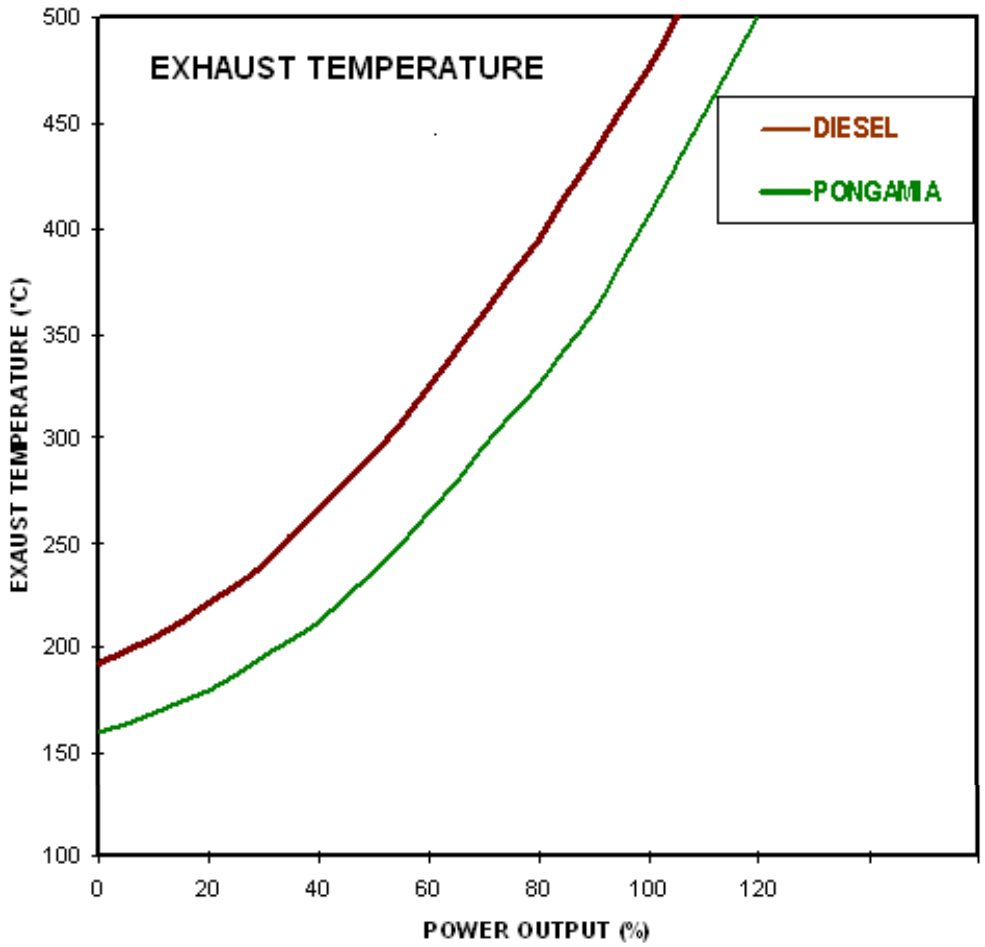
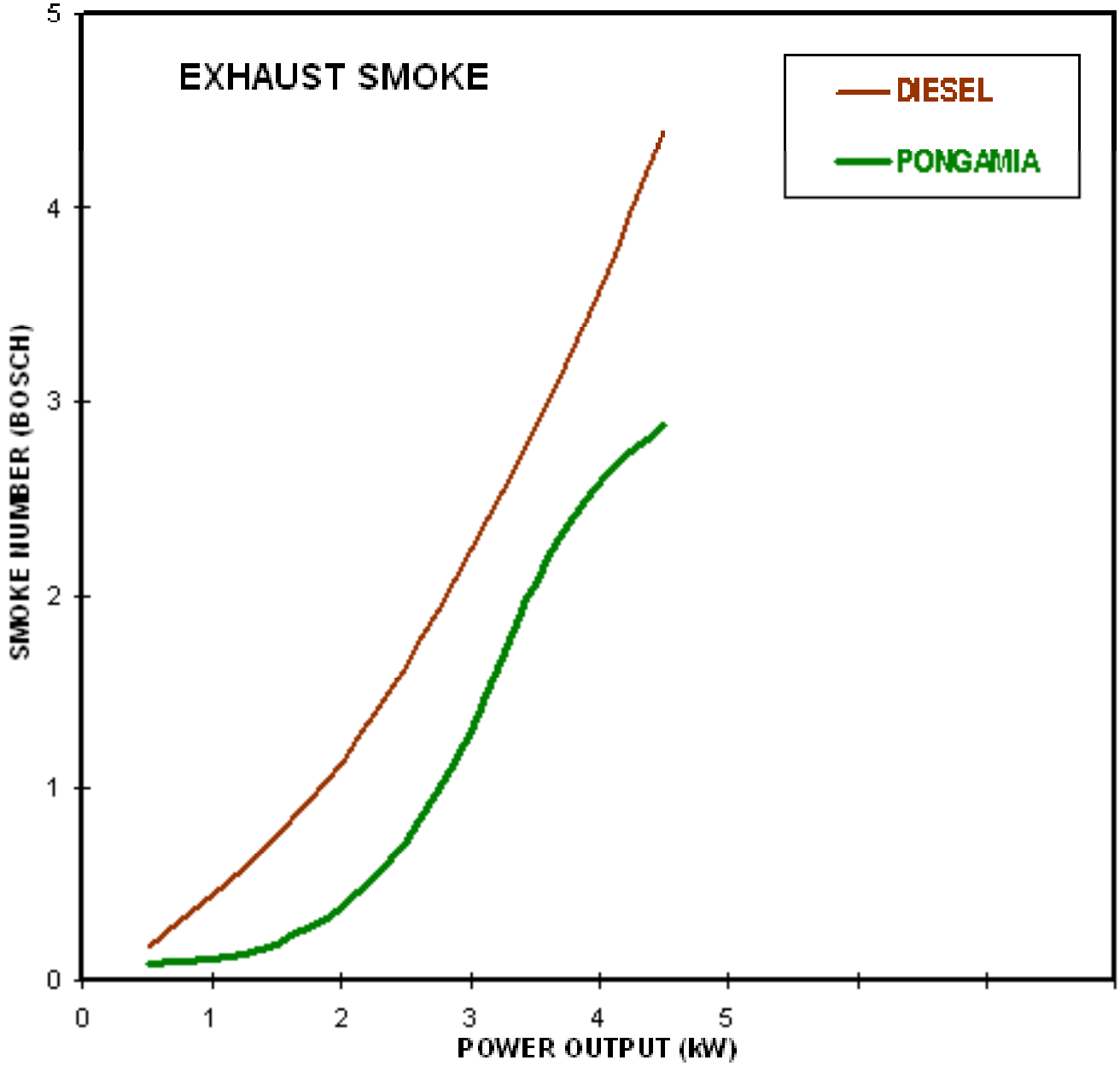

EXHAUST TEMPERATURE
DIESEL
PONGAMIA
EXAUST TEMPERATURE (°C)
500
450
400
350
300
250
200
150
100
0
20
40
60
80
100
120
POWER OUTPUT (%)



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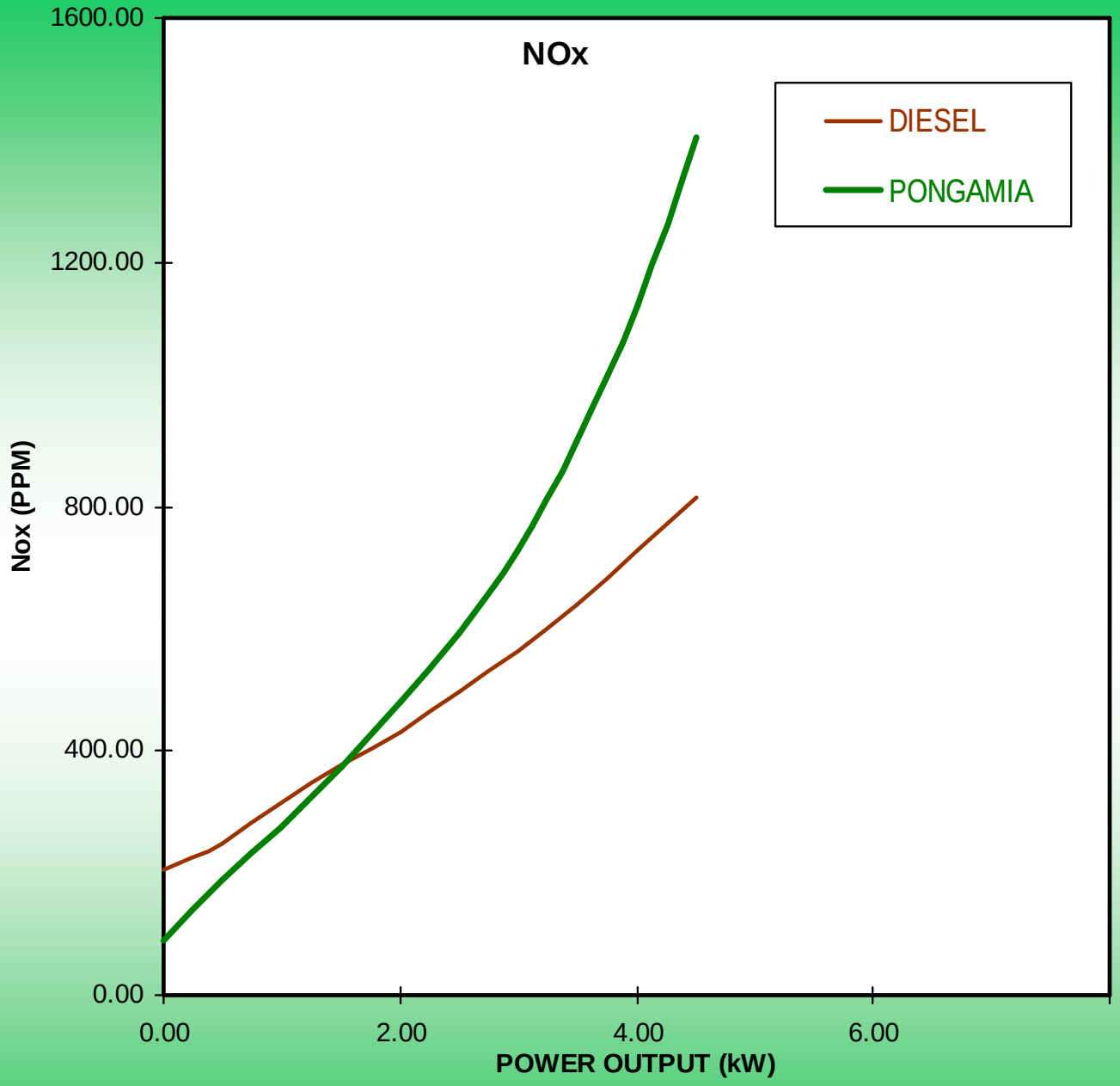

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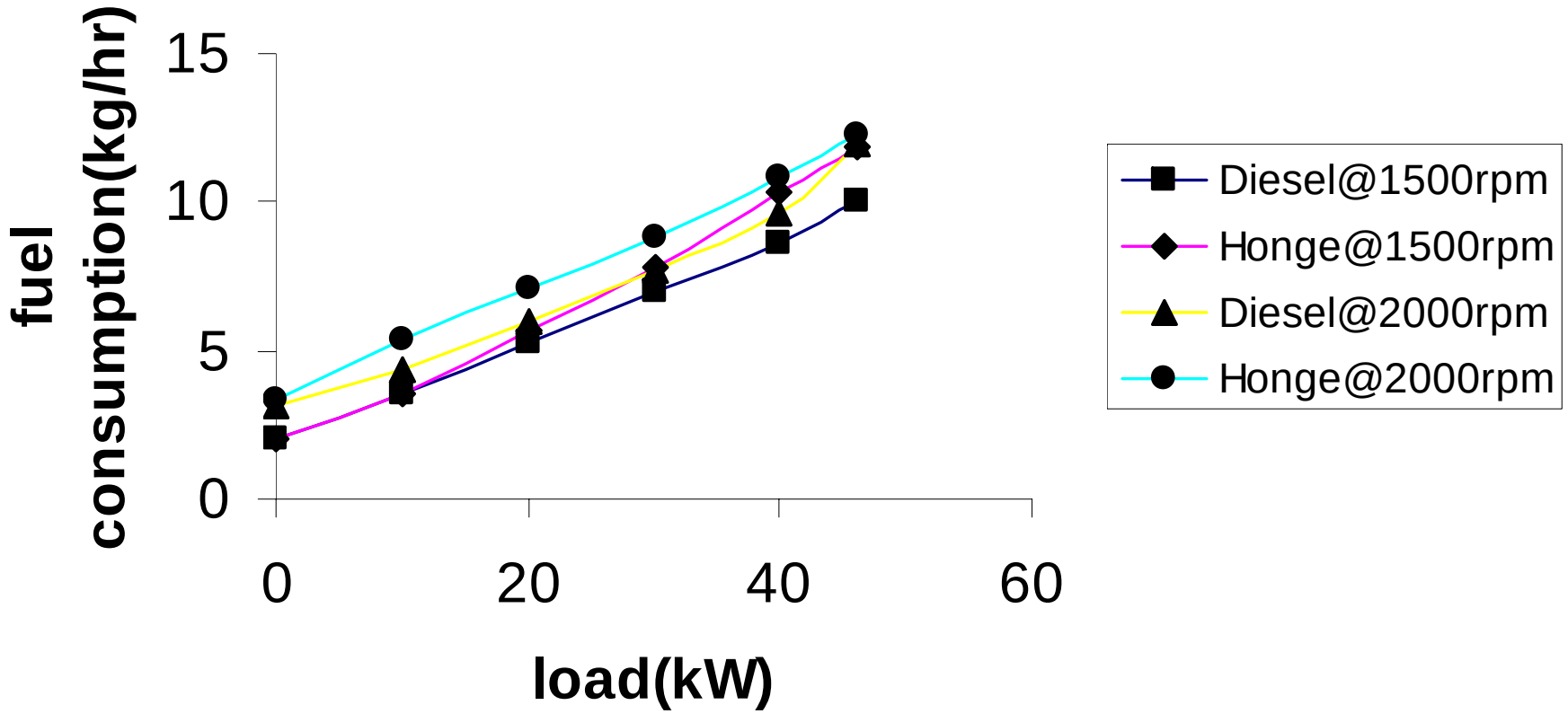
Fuel Consumption



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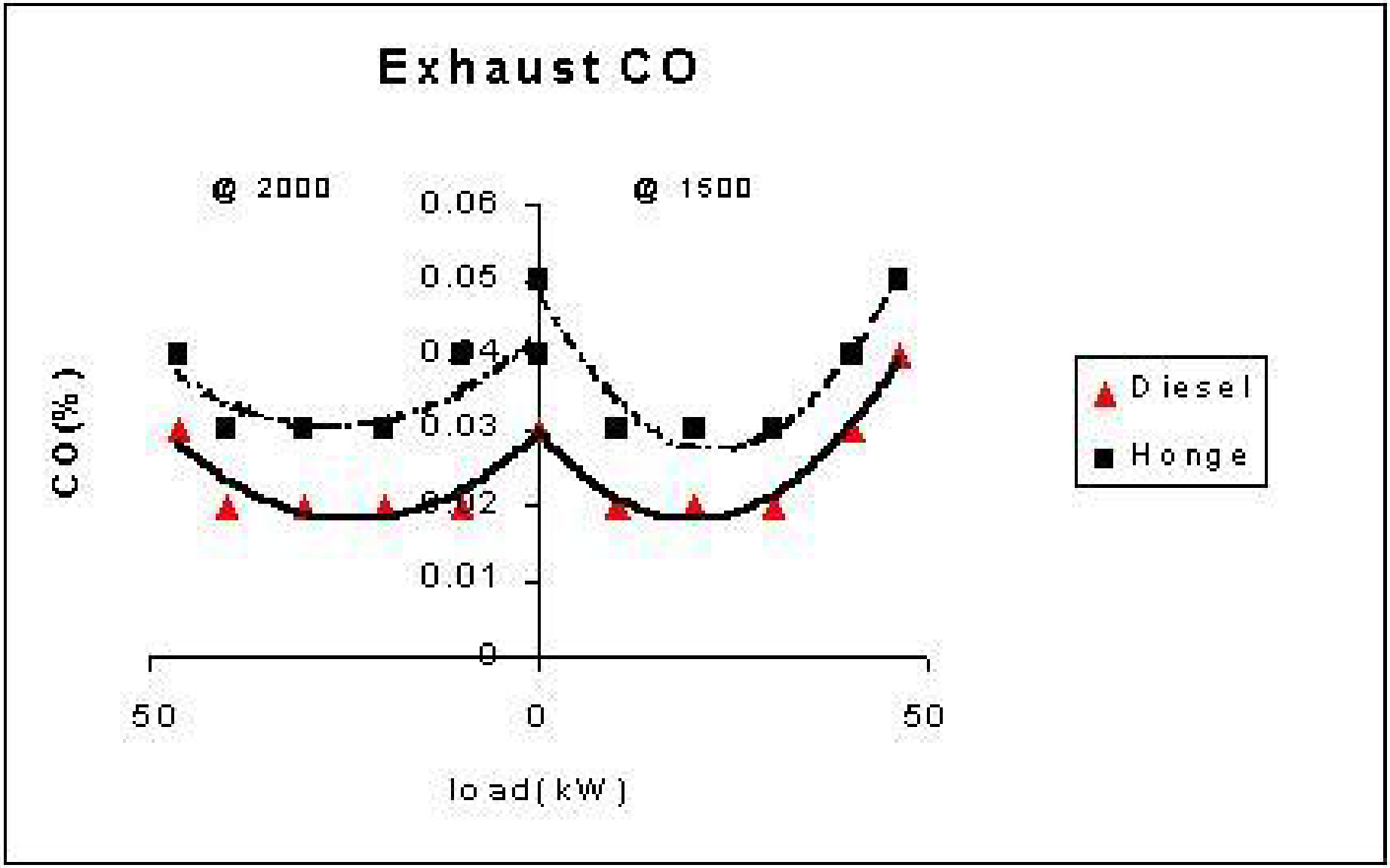

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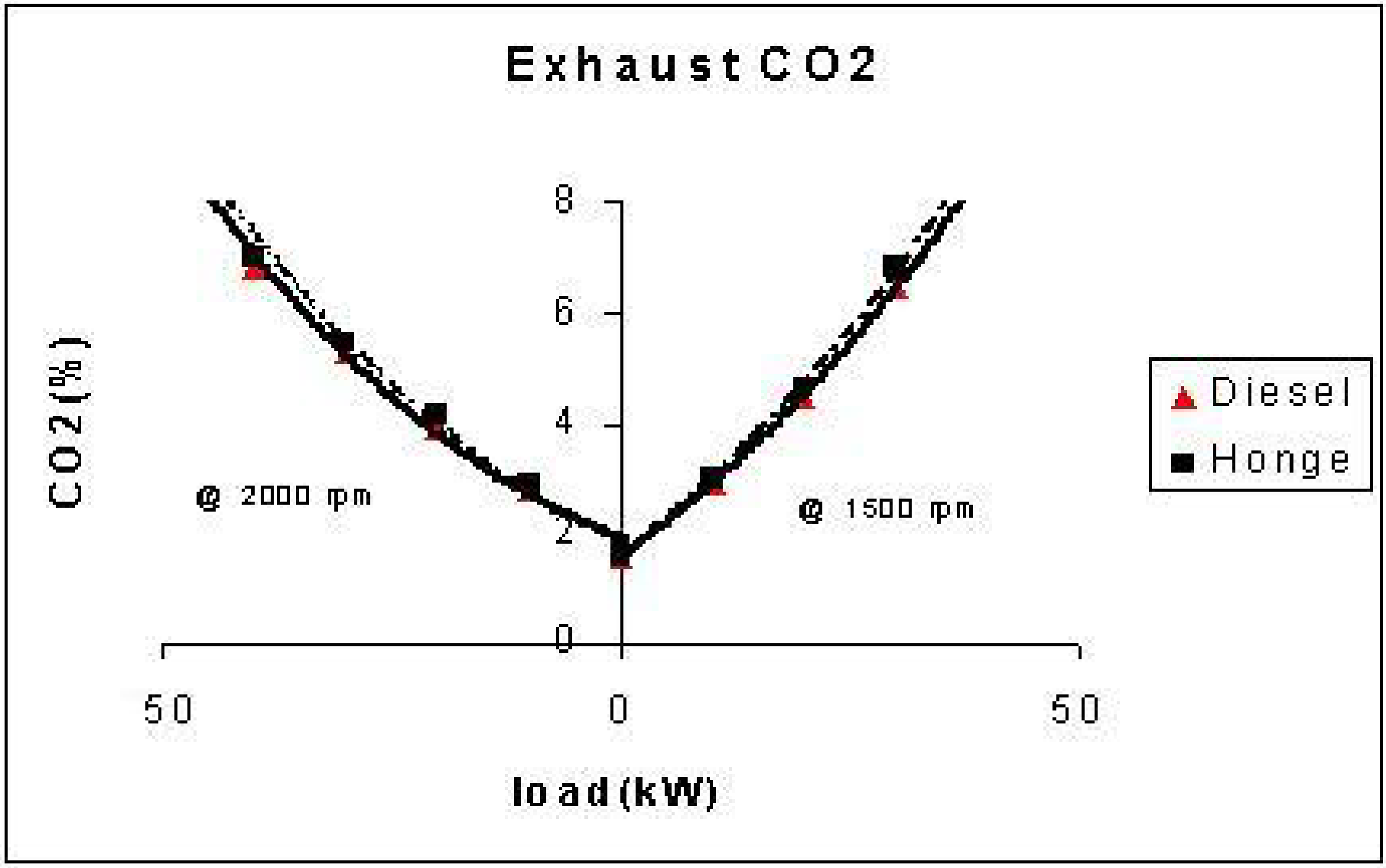

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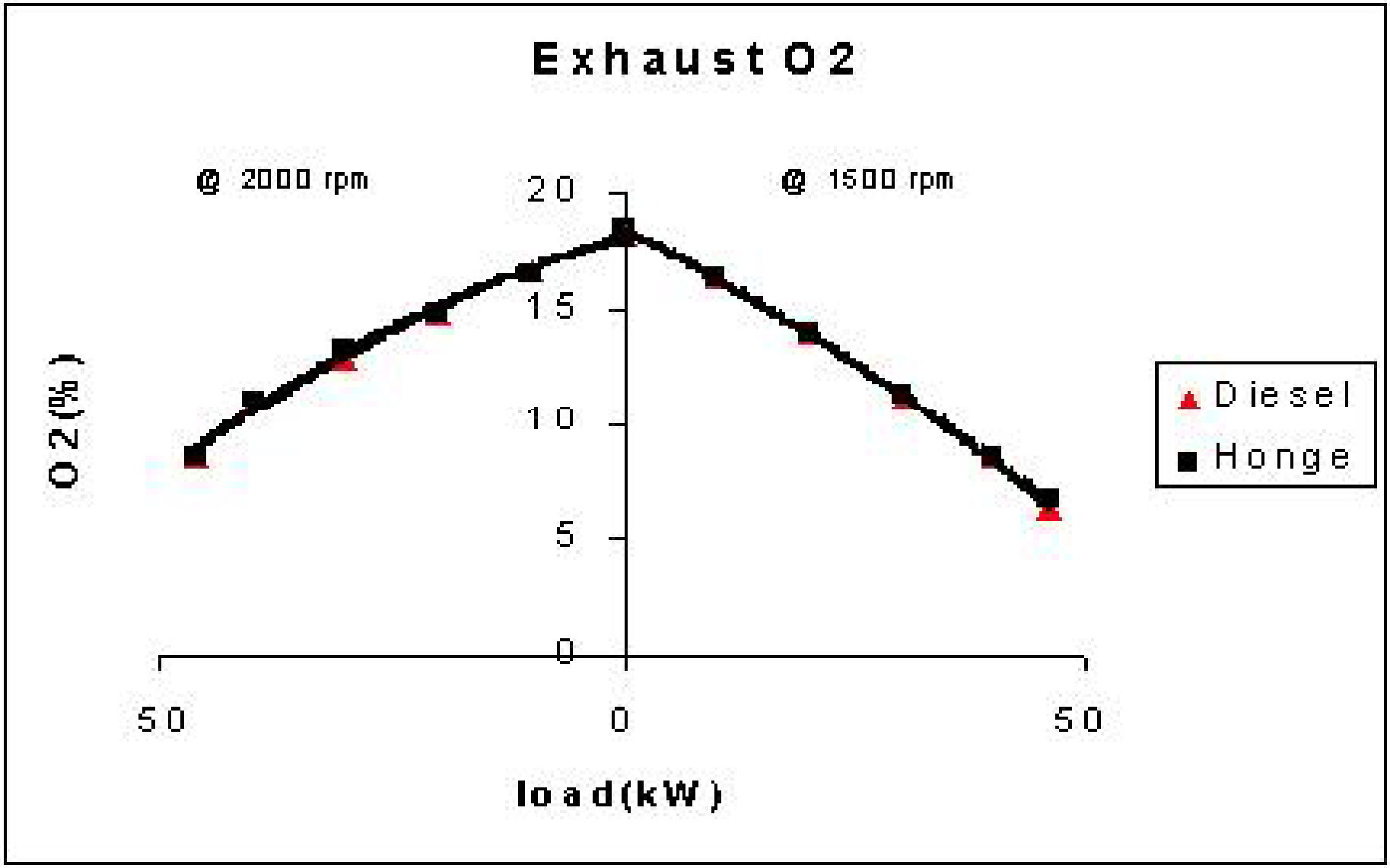
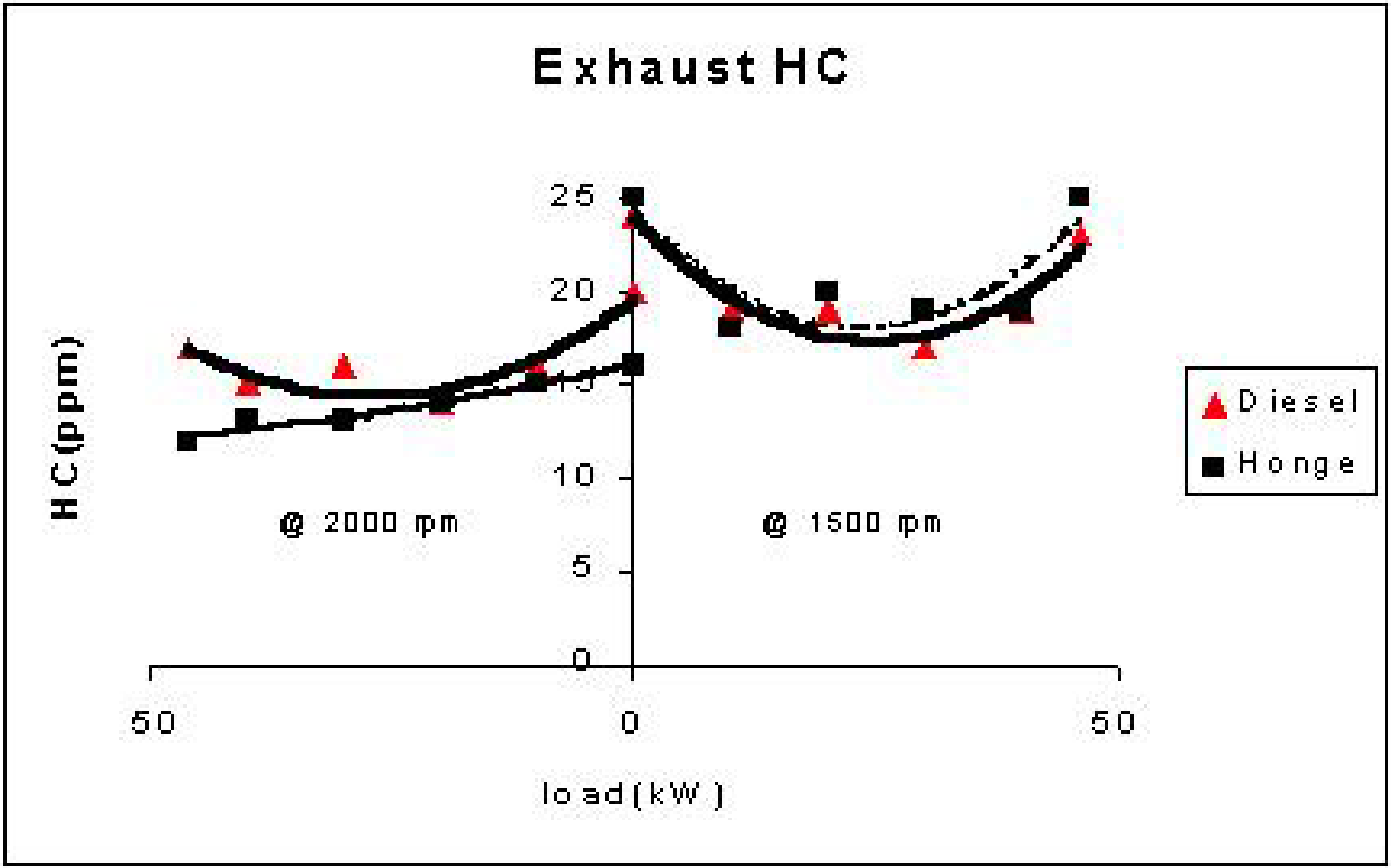

Exhaust O2
@ 2000 rpm
@ 1500 rpm
20
15
10
5
0
O2(%)
50
0
50
load(kW)
Diesel
Honge



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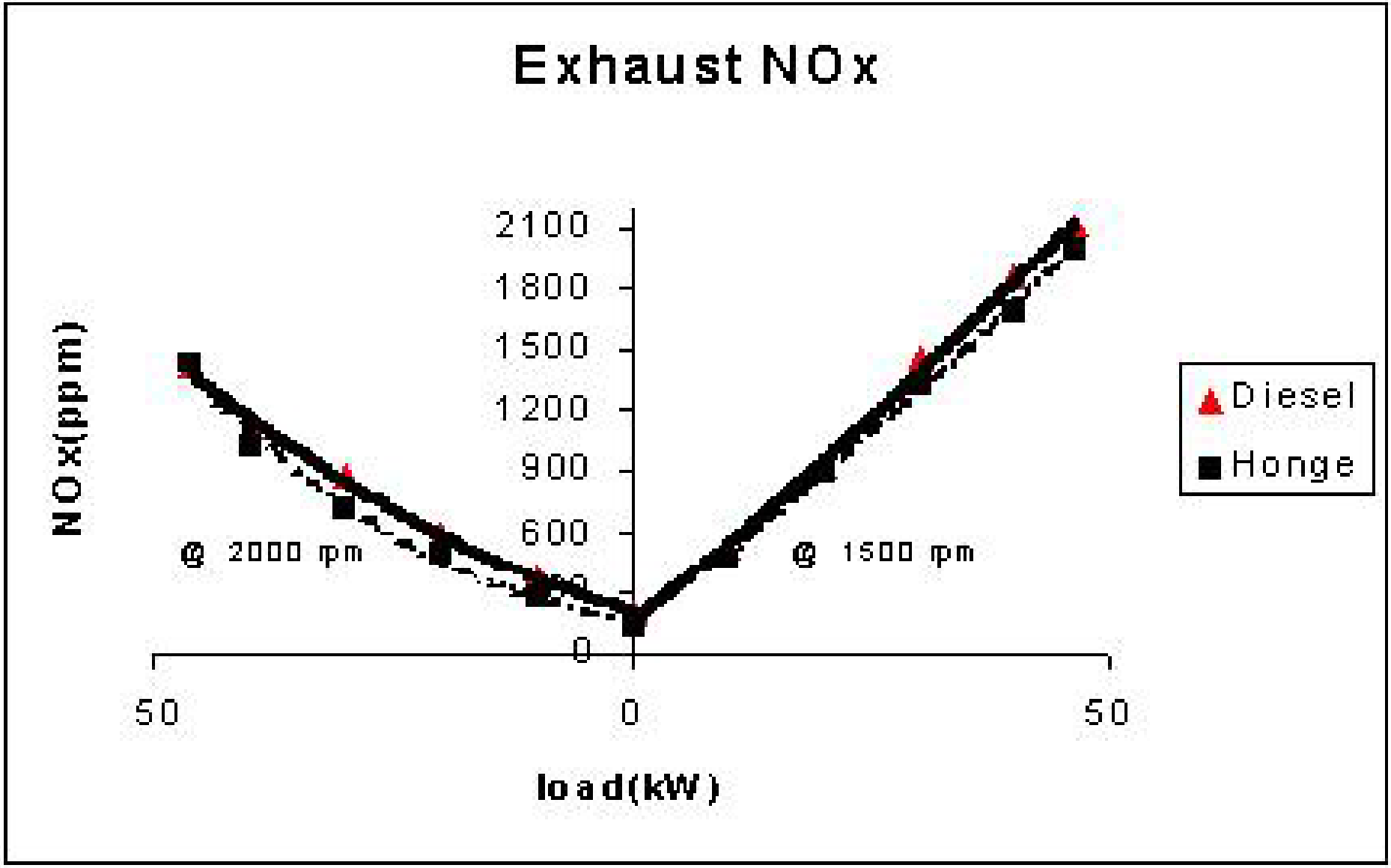

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Strategies for sustainable development

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The package deal

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The package deal II










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Sustainable organic fertiliser

Cake is a fertiliser	How much is available? • 4 kg Pongamia seeds → 1 kg oil + 3 kg cake
How much to apply Paddy 300 kg/ha Banana 2 kg/ha Areca 2 kg/ha	Advantages • Can be produced in the farm • Pest repellents • Market cost ~ Rs 5/kg

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Pongamia oil economics

Land use	On farm use
Seeds 10.0 tons/ha Oil 2.5 tons/ha Cake 7.5 tons/ha Seed price ~ Rs 5000/ton	Crushing and cleaning cost Rs 4/kg oil
In village area	**In urban areas**
Buy seeds Rs 5000/ton Sell seedcake Rs 5000/ton Crushing-cleaning charges Rs 1000/ton **Net oil cost Rs 9000/ton**	Bulk selling price of oil Rs 15,000 to 20,000/ton

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Use of oil

Crushed and filtered oil as SVO in villages	RBDD for power generation, blending with diesel and for bio diesel production in urban areas
Bio diesel for automobiles	RBDD oil and bio diesel for export

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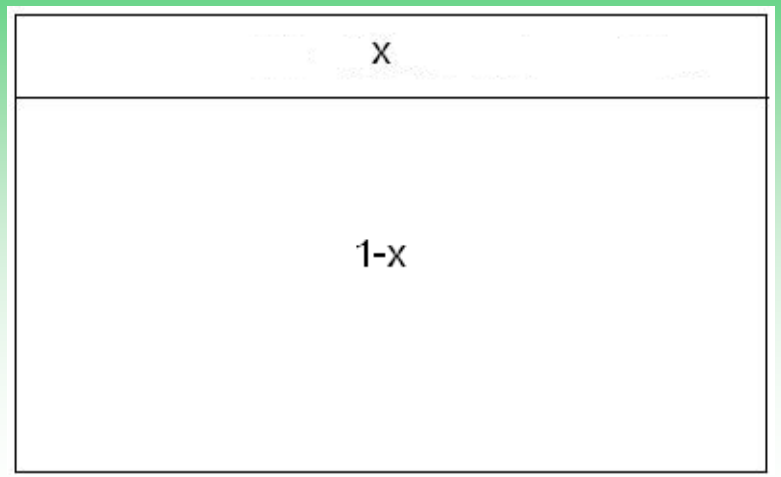
Strategy 1 – for agricultural land



$$x = 1/(1+((N_c*C_y)/(N_f*U_f*F))$$

***x* = 1/18 = 5.55% land to be dedicated for biofuel plantation**

x – Fraction of land used for Pongamia and Castor plantations

(1-*x*) – Fraction of land that remains for cultivation of crops

Nc – Nitrogen in cake = 0.05; Nf – Nitrogen in fertilizer = 0.46;

Cy – Cake yield/ha of *x* = 7500 kg; Uf – Useful fraction of urea = 0.33;

F – Fertiliser req. for crops = 150 kg

Fraction of land used for a biofuel plantation is decided based on cropping efficiency

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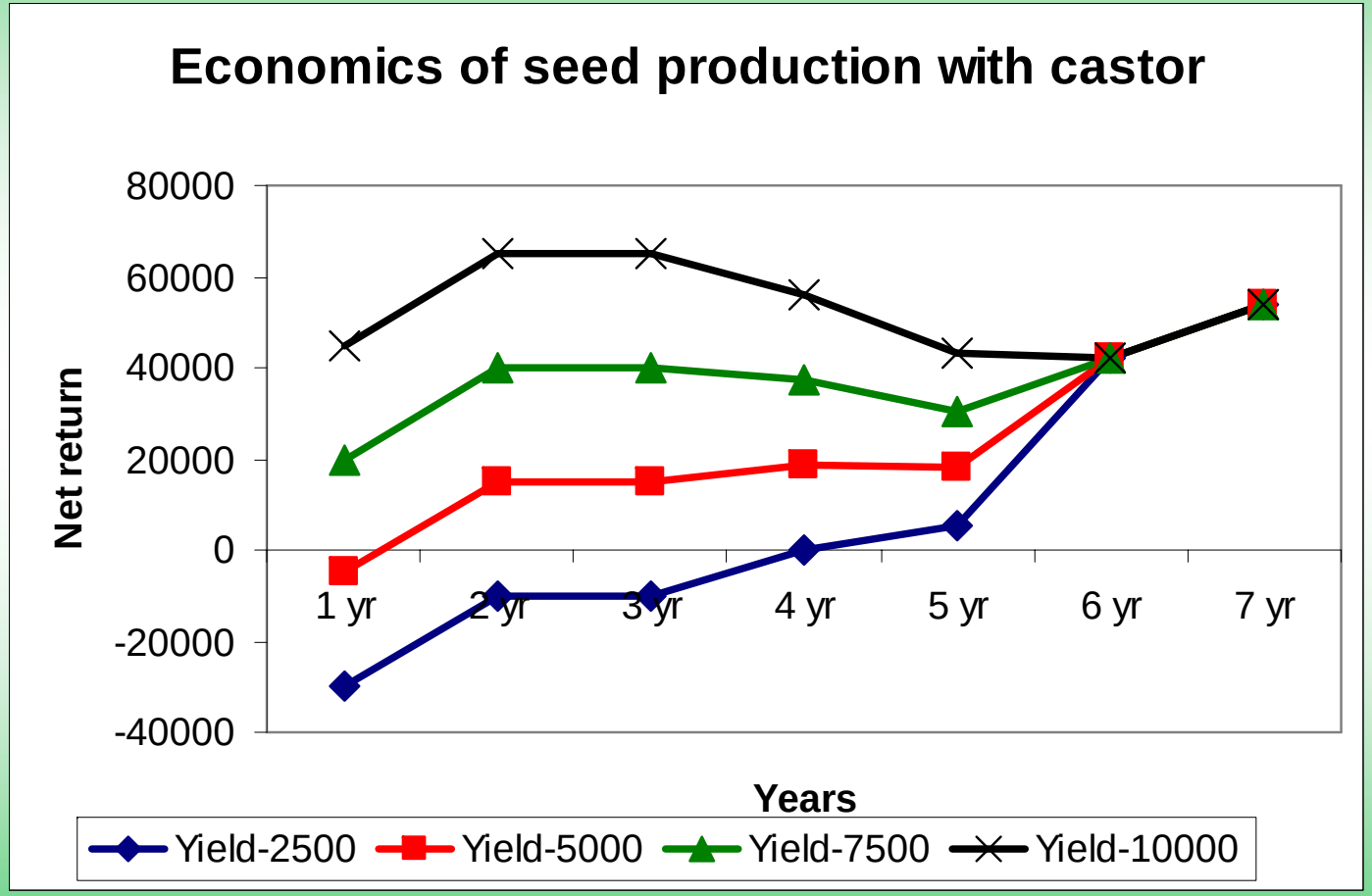
Economics of Strategy 1



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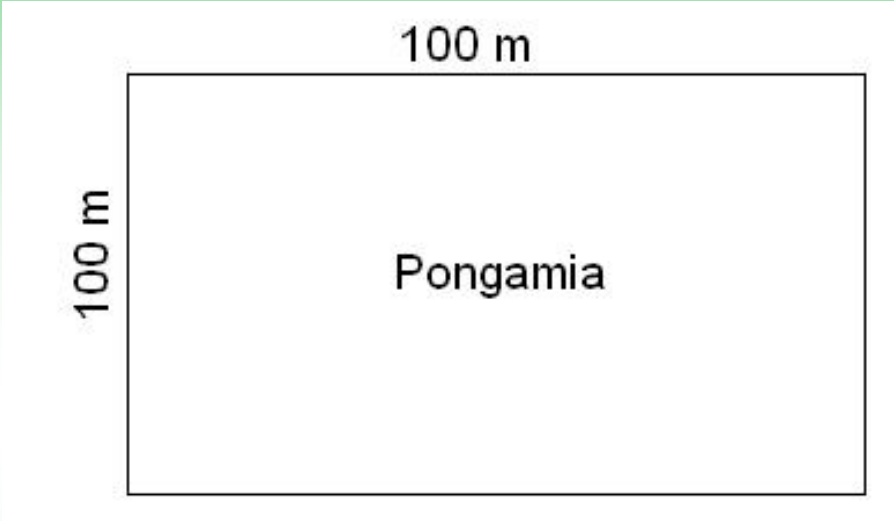
Strategy 2 – for wastelands



Yield :10 tons/ha

2.5 tons/ha of oil and 7.5 tons/ha of cake

Income 50,000 INR/ha

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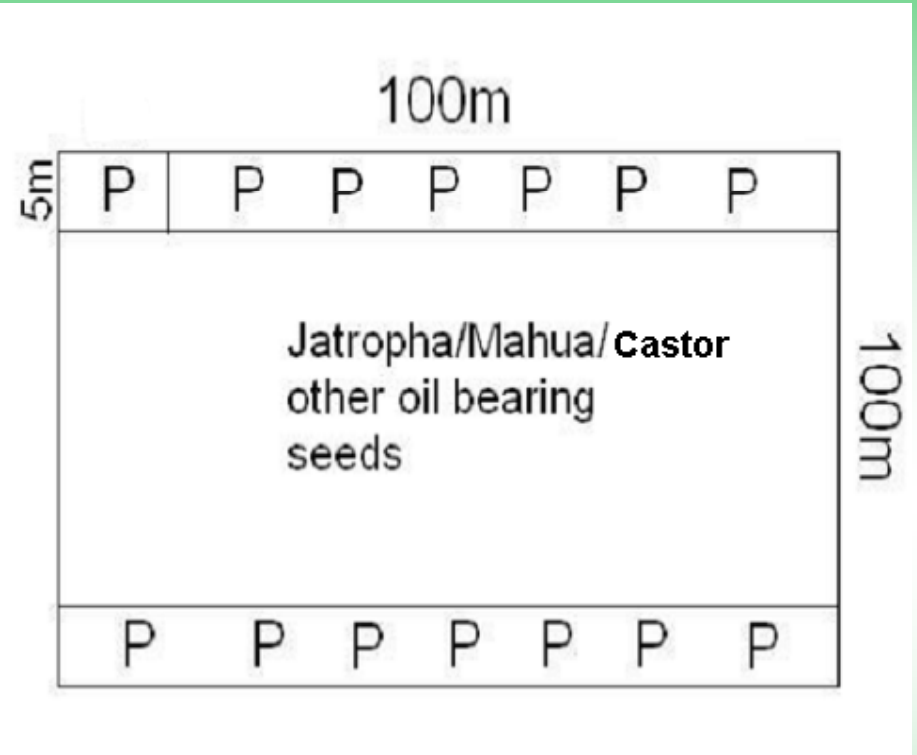
Strategy 3 – for marginal land



Pongamia will provide fertilizer for jatropha, mahua, castor and other oil seed bearing plants

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A quick strategy

- Promote 20% substitution with filtered oil
- Demonstrate

  diesel start – run on hot oil – diesel stop

  applications in villages to be used in the long run

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Biofuels in India

Opportunity knocking at our doors since Jan 1997

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Takes only 100 days to get the oil flowing!

Is a 100 billion dollar/year opportunity in India!!

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Land,

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water,

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and energy from biofuels

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will lead to long term all round development.

It doesn’t get any easier than this!

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Thank you

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