

Wärtsilä and Liquid Bio Fuels II

Sustainable biofuel development
Research Workshop 5th February 09

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GLOBAL TRENDS 2009



Growing pressure on natural resources

- Basic resources are under threat, including water, energy, food and forests
- threats exacerbated by climate change.
- Consumption of critical resources is already exceeding the rate at which the planet can renew them.
- The situation will worsen as consumption increases globally.

Source IMD, Global trends

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Electric Energy: Global growth perspective

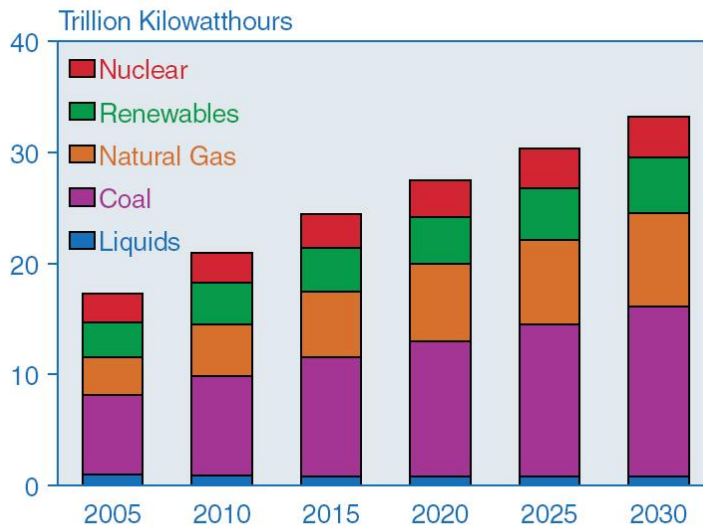
- World electricity consumption to grow by 2.6% per year through 2030
- Main areas of growth:
 - Asia: India 5.4% growth per year, China 4.9% per year)
 - Europe: will grow by about 1.4%
 - Middle East: Average growth of 3.8%

Sources: EIA, IEA

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World Electricity Generation by Fuel, 2005-2030

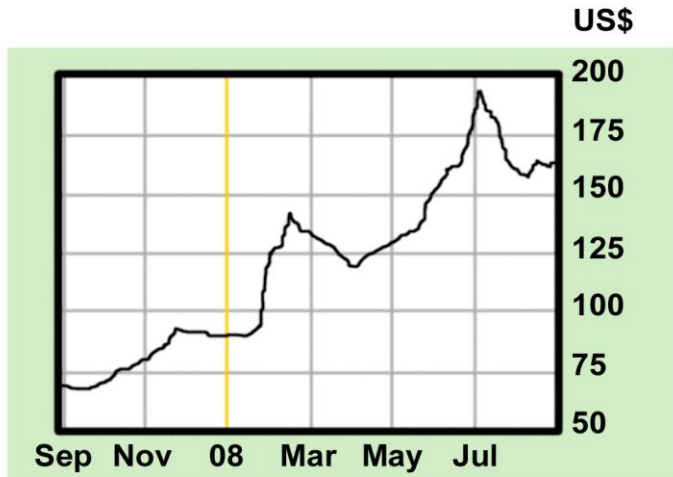


EIA Outlook 2008

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Coal prices have nearly doubled this year



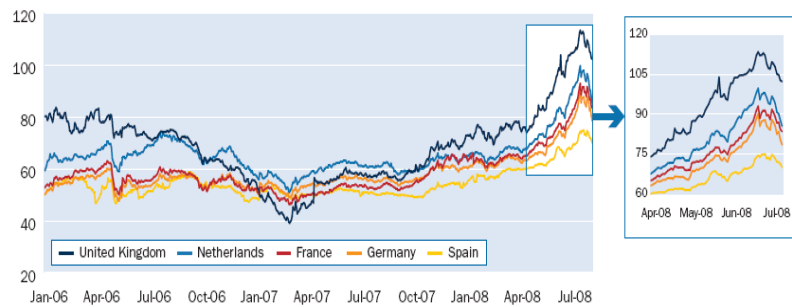
Thermal coal prices at Australia's Newcastle port

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Increasing power prices

Platts Year Ahead Base Power Assessment (€/MWh)



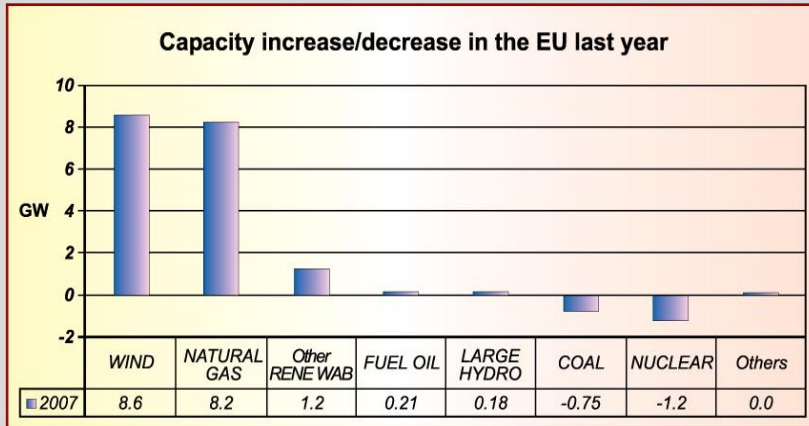
Source: Platts

Power prices increased by about 50% in the April-July 08 quarter

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Renewables in Europe



Renewables accounted for **50% of capacity additions** in Europe last year

Source: European Renewables Council

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Renewable fuels

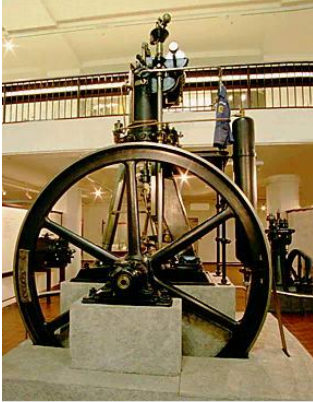
WHAT IS THE POSITION OF A TRADITIONAL ENGINE BUILDER ?

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Historic View

Rudolf Diesel (1853 – 1913) presented an engine operating on **peanut oil** in 1900.

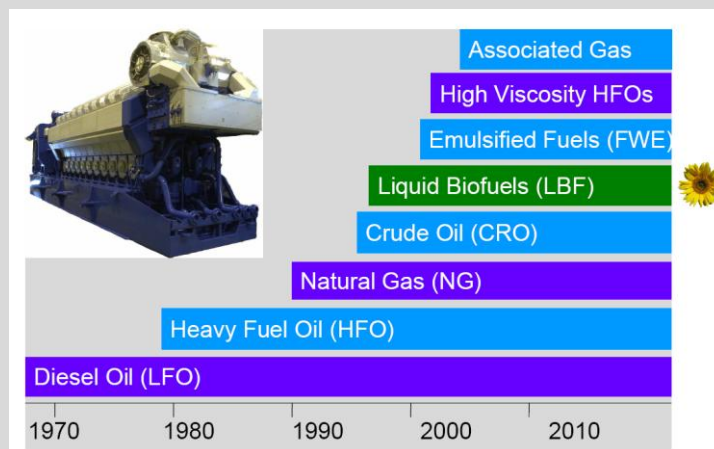


In 1912 he stated:
“The use of vegetable oils for engine fuels may seem insignificant today. But such oils may in course of time become as important as petroleum and the coal tar products of the present time.”

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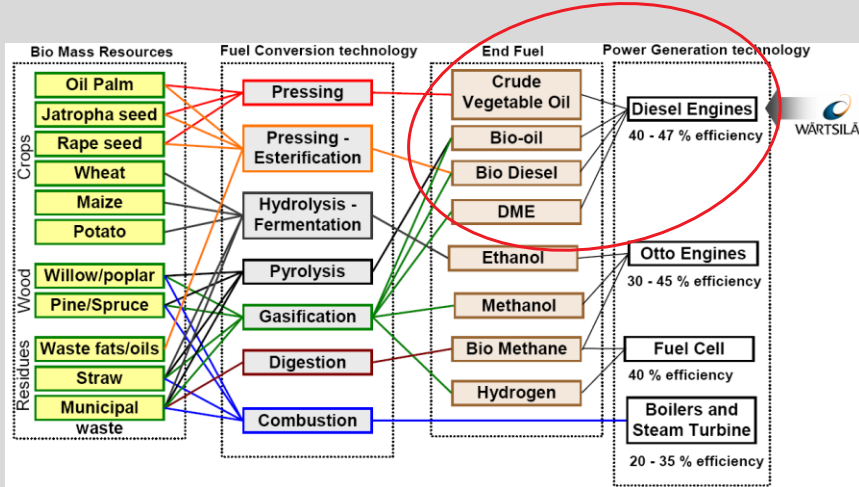
Wärtsilä Fuel Versatility



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Biomass derived end fuels

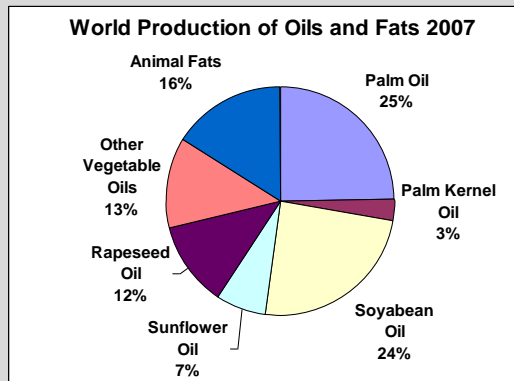


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World Production of Oils and Fats 2007

- 2007 Total production 154 million tonnes (Jatropha oil not included)
- 2007 Total world consumption of mineral crude oil 3953 million tonnes (BP)

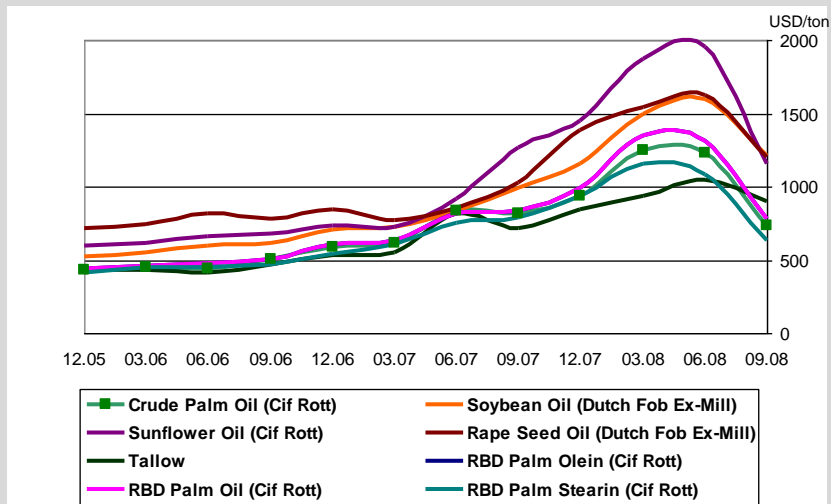


Source : Oil World Annual (1999 - 2007) & Oil World Weekly (14 December, 2007).
 Source : MPOB - For data on Malaysian palm oil and palm kernel oil.
 Source : BP Statistical Review of World Energy

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Vegetable Oil Price Development



- There is no commodity market for Jatropha oil yet

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The Variety of Liquid Biofuels

- **A great variety of bio fuels exists**

– **Tested, Verified and Approved** by Wärtsilä are:

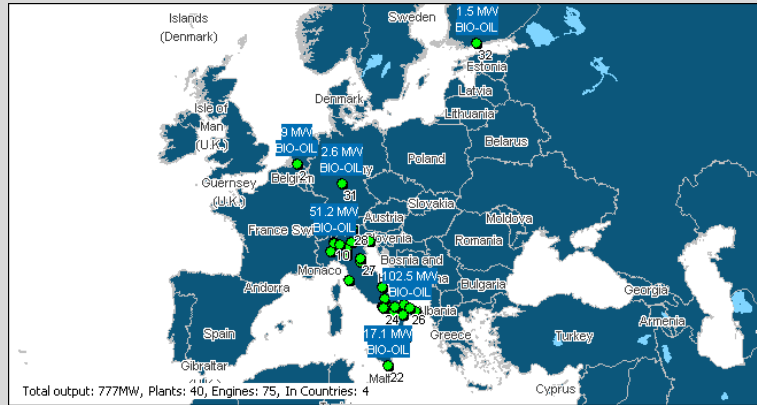
- Vegetable based biofuels:
 - Palm oil
 - Palm stearin
 - Jatropha oil
 - Rape seed oil
 - Soya oil
 - Sunflower oil
- Transesterified oils (biodiesel)



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Liquid Biofuel References in Europe



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IGE Block 1, (Pentesilea) 24 MW

- Location: Monopoli, Italy
- Prime movers: 3 x Wärtsilä 18V32
- Output: 24 MW_e
- Fuel: Liquid biofuel (Mainly palm oil)
- Steam is generated with exhaust gas boilers for a olive oil refinery & biodiesel production plant
- SCR is installed for NO_x abatement
- The power plant started up in August 2004
 - Engines 1 & 2 have over 30,000 operating hours
 - Engine 3 has over 25,000 operating hours since July 2005
 - Availability > 95%



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IGE Block 2, 100 MW



Location: Monopoli, Italy
Prime movers: 6 x Wärtsilä 18V46 + Steam turbine
Output: 100 MWe (engines) + 11 MWe (turbine)
Fuel: Liquid biofuel (mainly palm oil)
Emission control: SCR NOx abatement

Operation of 3 first engines started in January 2008, currently more than 4000 operating hours

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Unigrà , 50 MW

- Location: Conselice, Italy
- Prime movers: 3 x W18V46 + combined cycle
- Output: 50 MWe1 (engines) + 6 MWe1 (steam turbine)
- Fuel: Liquid biofuel (palm oil)
- Emission control: SCR NOx abatement

- Hand-over in September 2009



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Koekhoven Project , 9MW

- Location: Merksplas, Belgium
- Prime mover: 1 x W20V32
- Output: 9 MWeI + 7.5 MWth (Hot water)
- Main fuel: Liquid biofuel (Jatropha oil)
- Emission control: SCR NOx abatement
- The heat produced by the plant is supplied to:
 - a drying facility for digested biomass recovered from a manure fermentation plant
 - a greenhouse producing tomatoes
- The 9 MW Wärtsilä 20V32 engine will provide electrical power sufficient to serve approximately 20,000 households
- The gross electrical efficiency is 44.2% and an overall efficiency of more than 85%, annual savings of CO₂ will total more than 36,000 tons.
- Expected start up during Q2 2009



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Koekhoven Project , 9MW

IPP, Special Purpose Company

50% shares Thenergo (Belgian Developer),
40% shares by four agriculture companies
10% shares by a private person

POWER PURCHASE AGREEMENT

10 Years with Electric Utility
Selling Price = 186 €/MWh

COMMENTS: 2007 estimate based on ,

- | | |
|---------------------------------|-----------------------------------|
| • Grey Electricity price | = 50 €/MWh + |
| • Flemish Belgium Green subsidy | = 80€/MWh |
| • CHP certificate | = 40€/MWh (depends on the market) |
| • Ecology premium | = 16 €/MWh (call system)] |

FUEL, JATROPHA

Source from South East Asia (most likely Thailand)

Comment : There is no Jatropha oil world market, hence price is difficult to predict.
However its expected to be at same level as Palm Oil at the moment.

FINANCING

Bank lease construction from a Belgian bank (KBC).

Source Wartsila

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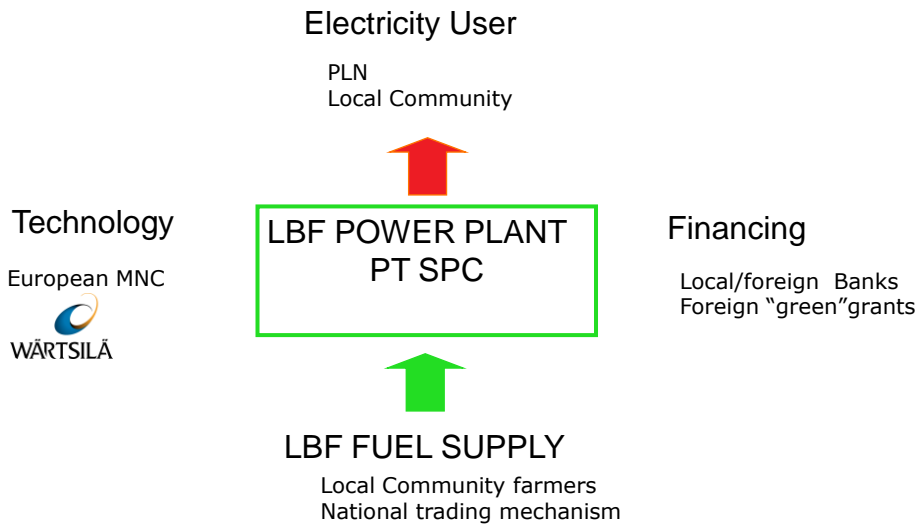
COULD IT WORK IN INDONESIA

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COULD IT WORK IN INDONESIA

Players ?



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Success factors

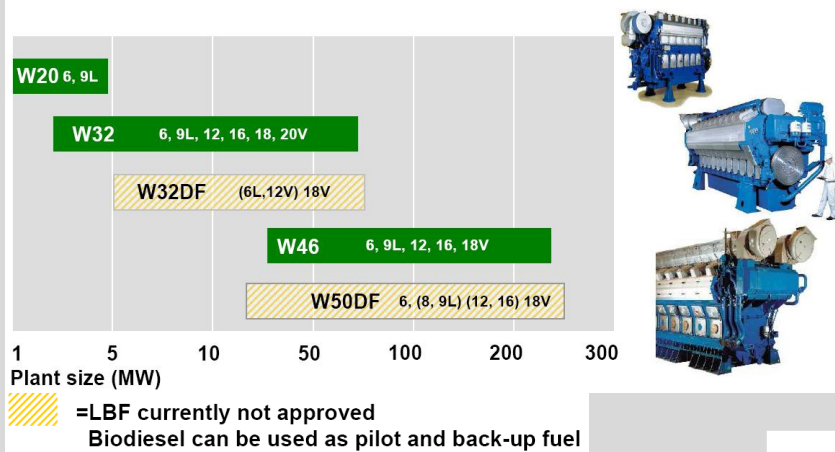
- Legal framework for green power generation.
- Green electricity price tariffs
- Long term supply of large quantity Jatropha oil
- Financing

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Technology exists - Liquid Biofuels Plants

Plant ranges & Engine portfolio



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Power Plants

We provide superior value to our customers with our distributed, flexible, efficient and environmentally advanced energy solutions, which enable a global transition to a more sustainable and modern energy infrastructure.

THANK YOU