GLOBAL FORUM

On Flaring and Venting Reduction and Natural Gas Utilisation

Operational Experience with a Gas-Diesel Engine running on flare gas

Dr. Jacob Klimstra
Wärtsilä Power Plants
www.wartsila.com

The subject/object: Secoya

GLOBAL FORUM
On Flaring and Venting Reduction and Natural Gas Utilisation

- **Secoya (Dygoil), Equador**
  - **Engines: 2 x Wärtsilä 16V32GD**
  - **Electrical output: 11 MW**
  - **Type:Fuel sharing, Island mode**
  - **Location: Ecuador**
  - **Owner: Petro Ecuador**
  - **Delivered: 2003**
  - **Speciality: Operates on either associated gas or CRO, or both simultaneously.**

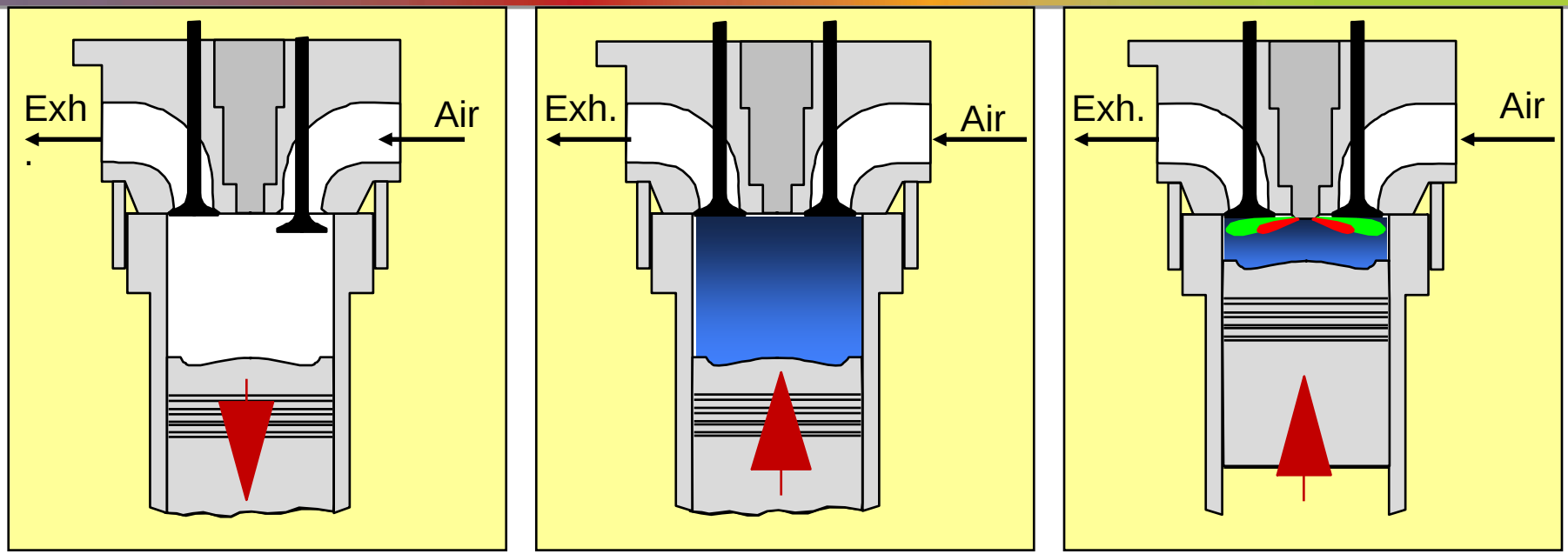
2 x Wärtsilä 16 cylinder GD engine

GLOBAL FORUM
On Flaring and Venting Reduction and Natural Gas Utilisation

Electrical output:

5.5 MW per unit

The gas – diesel (GD) working principle



Air Intake

Compression of Air

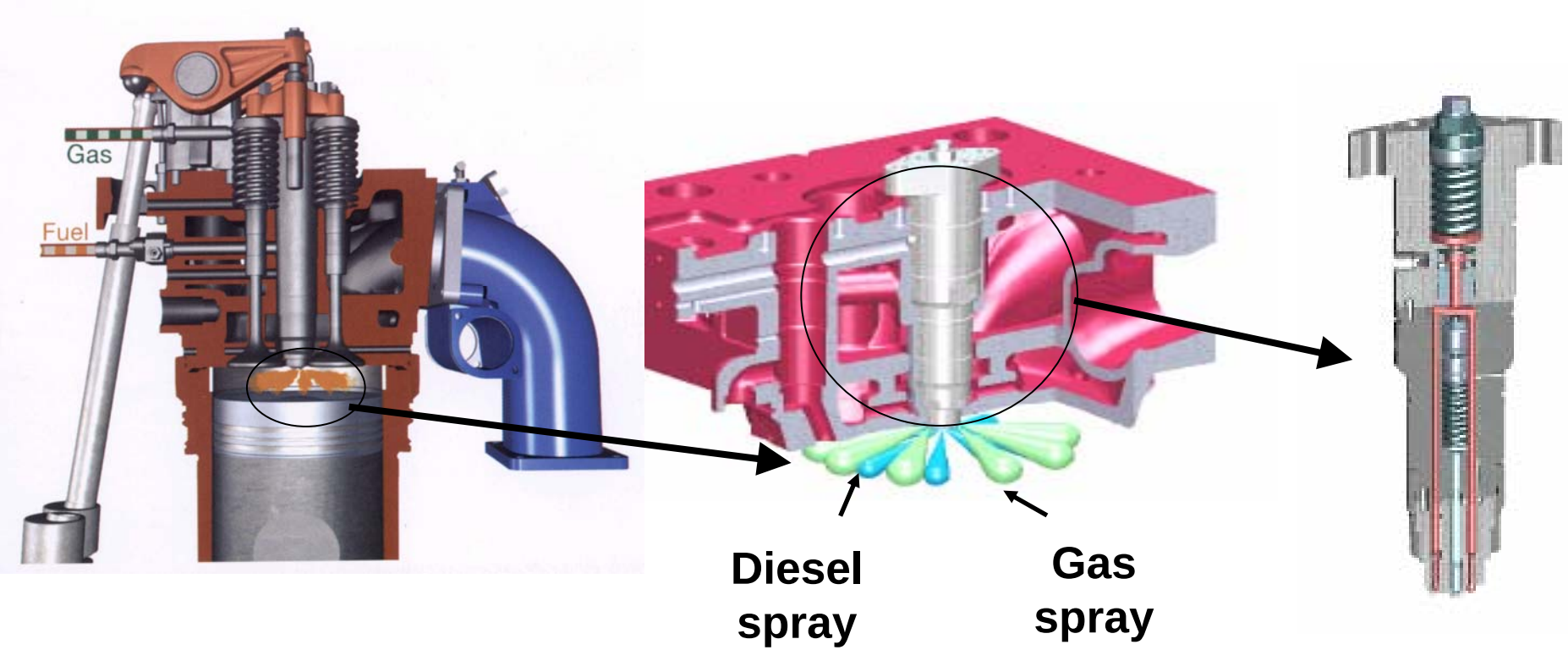
Injection of Gas and Pilot Fuel Ignition

Diesel fuel serves as the igniter

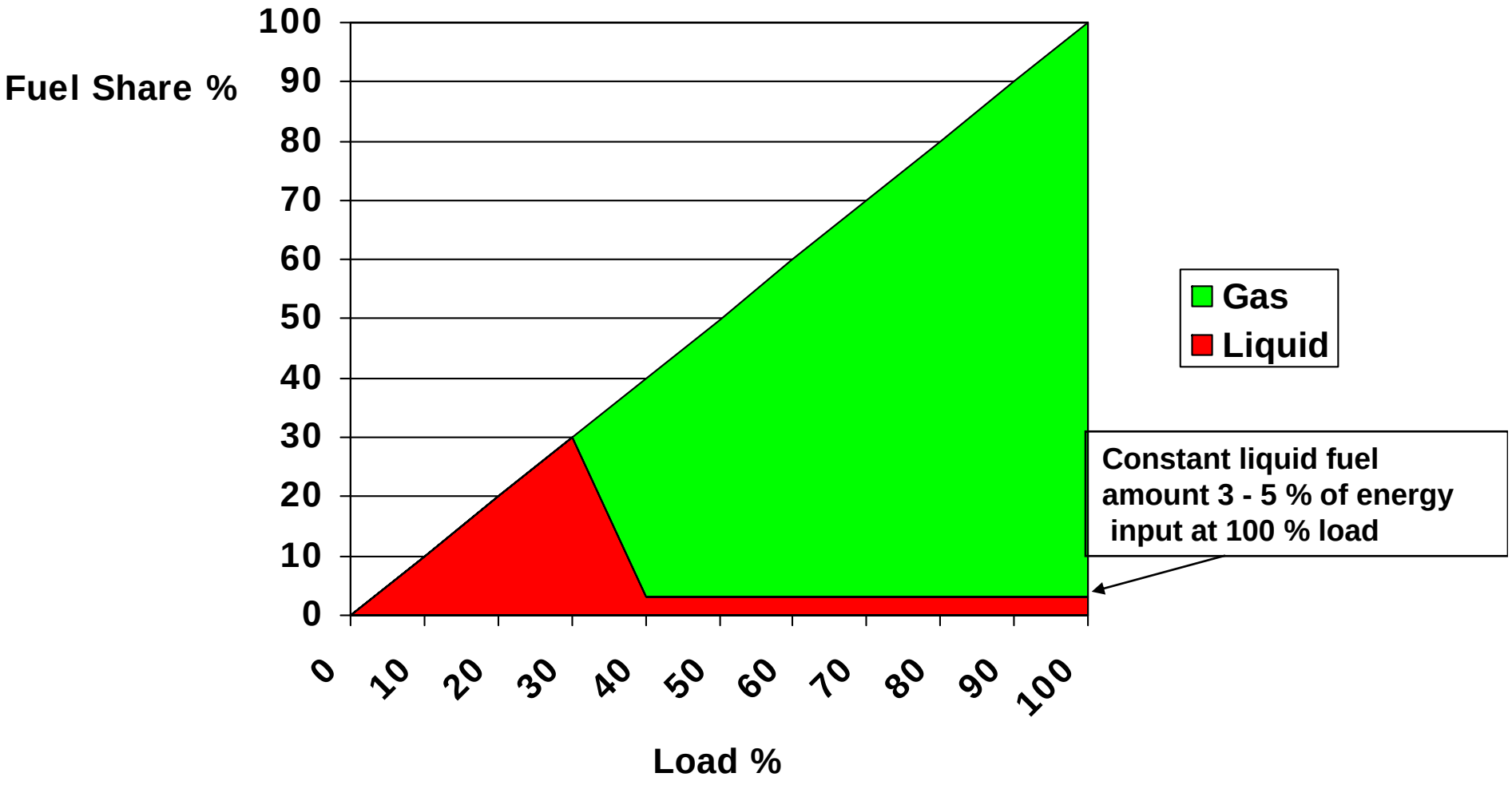
Gas is injected simultaneously with the diesel

Knocking can not occur

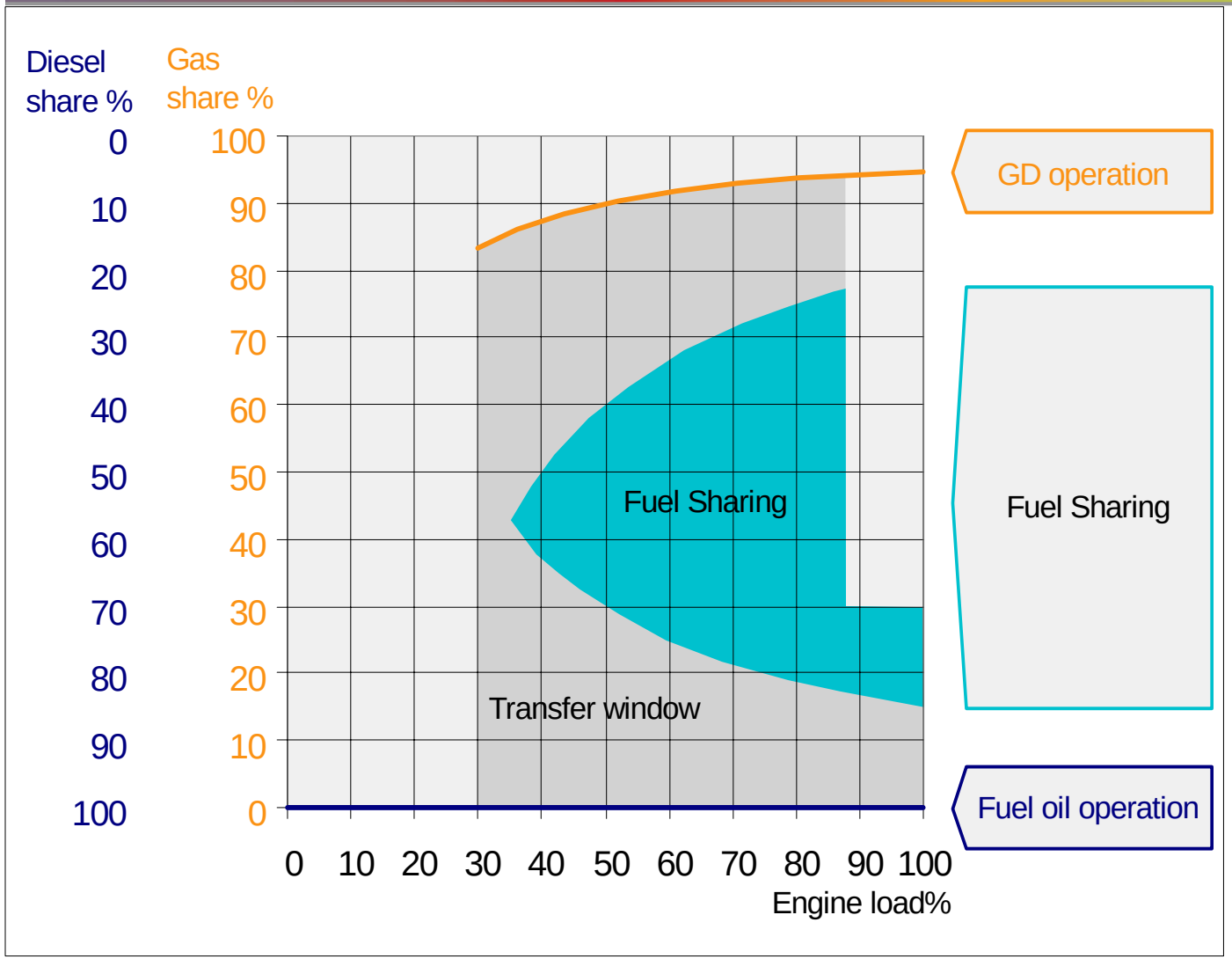
Essential components



Operation in ‘full’ gas mode



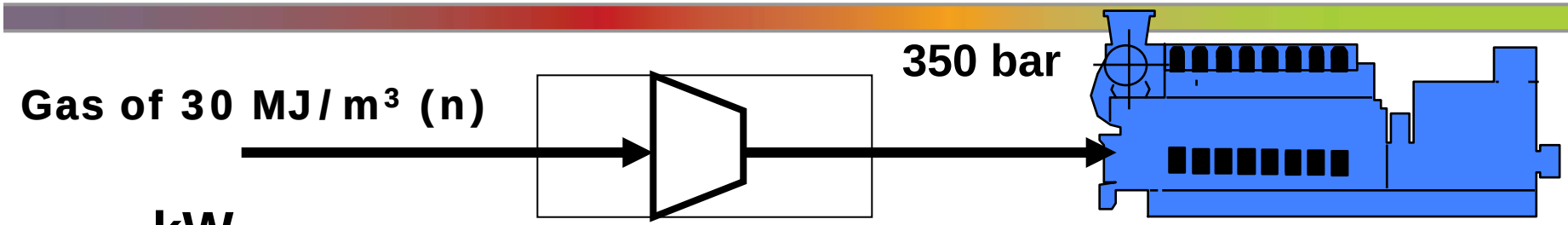
No power problem if the gas flow varies

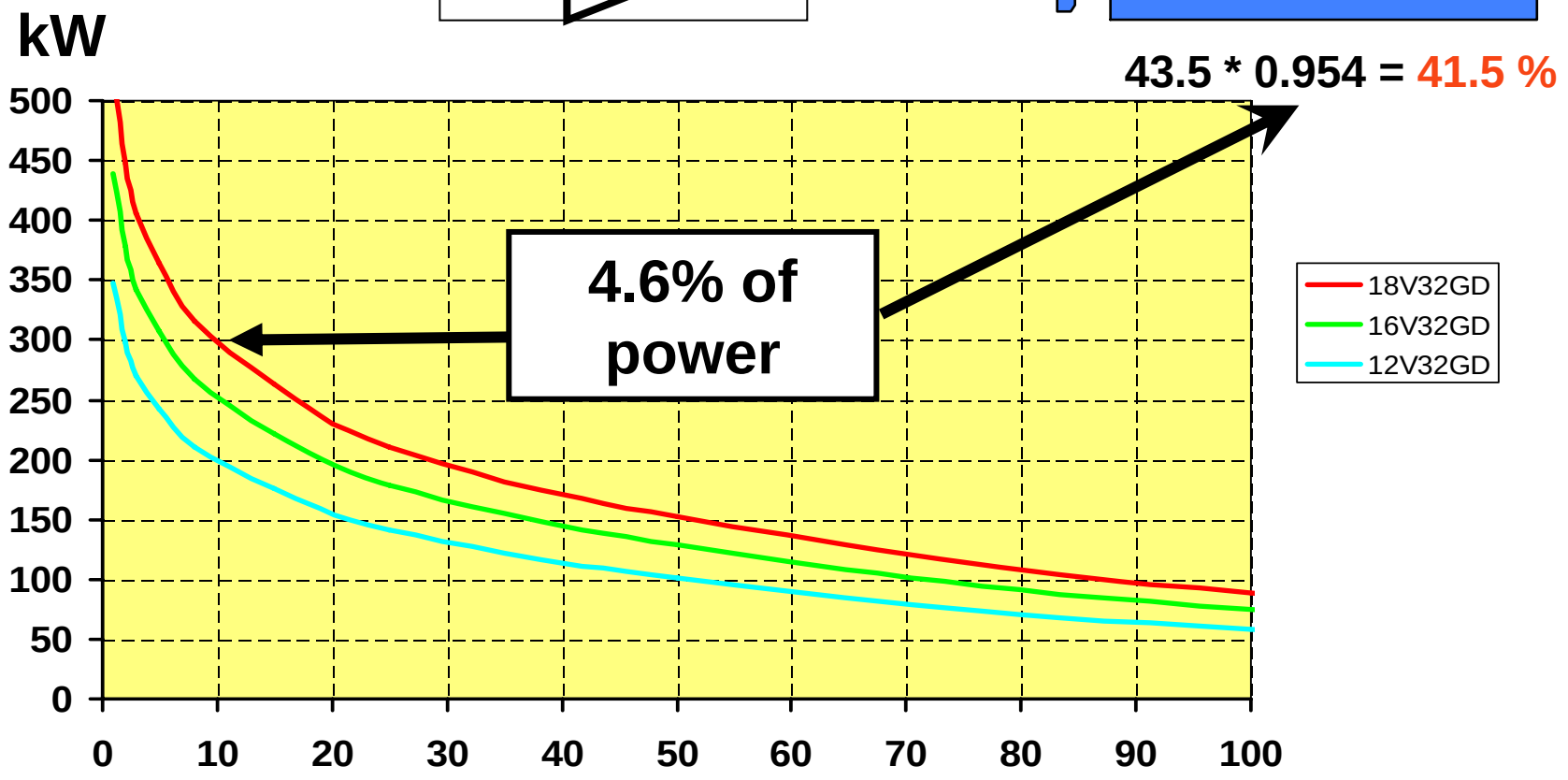


diesel pilot

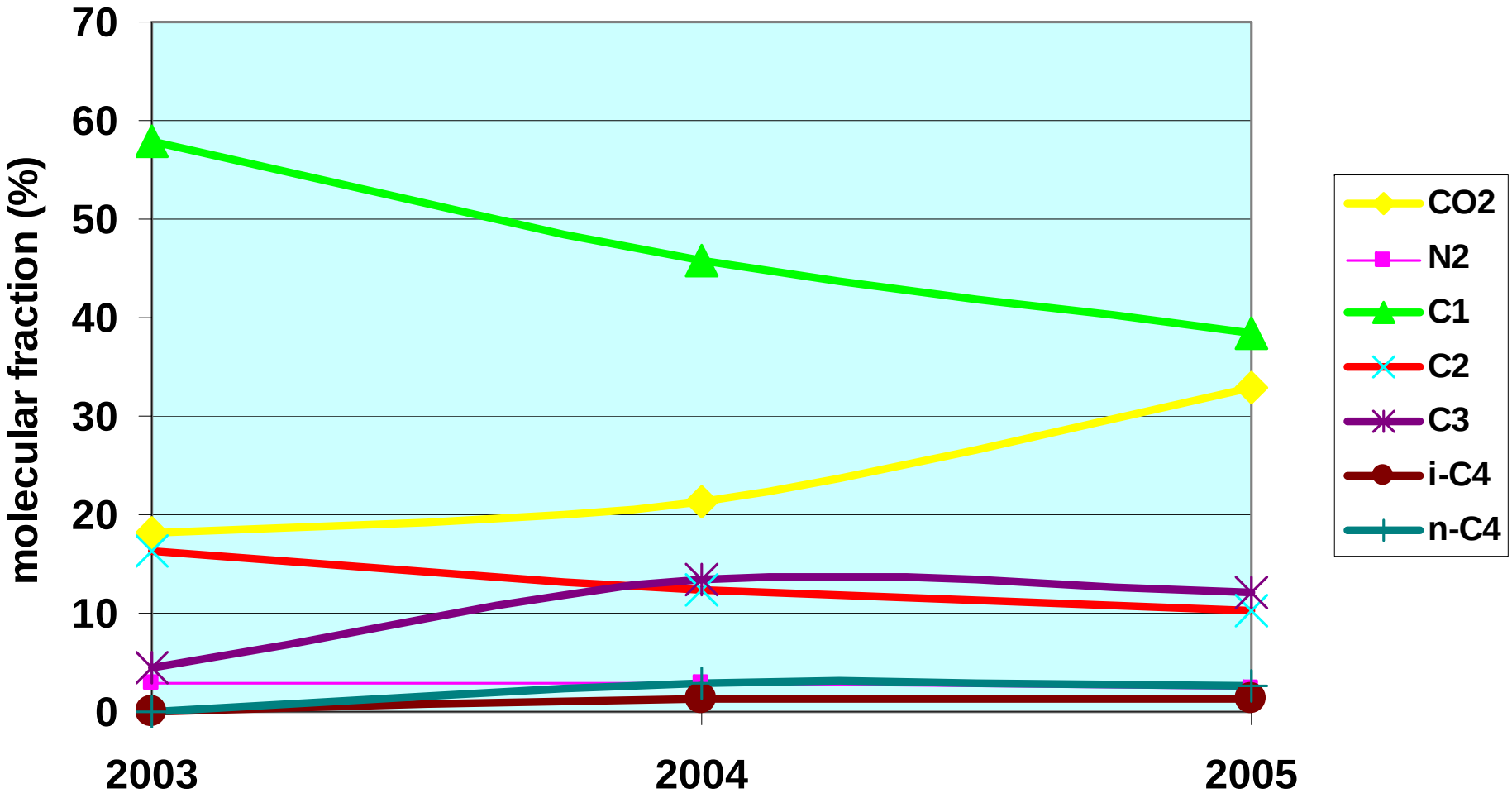
gas and oil share adjustable

The engine needs compressed gas





Varying gas composition

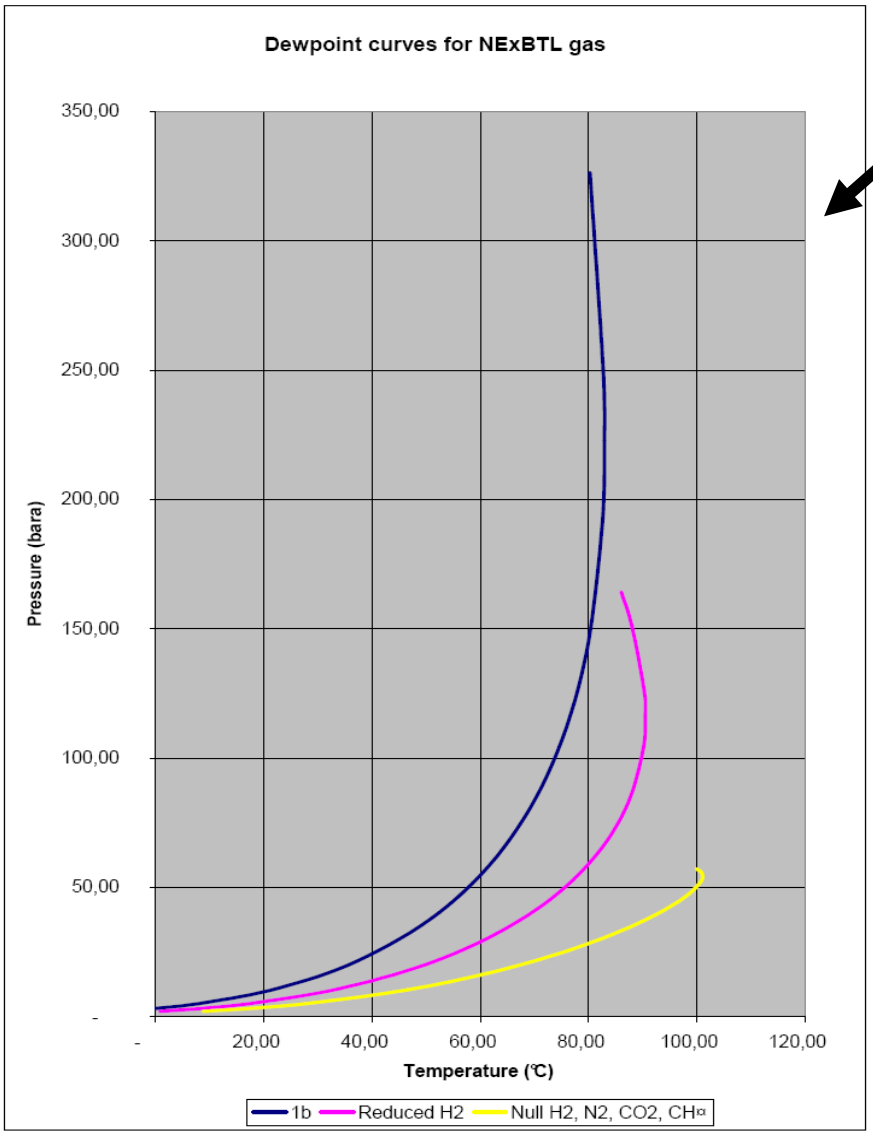


Varying gas properties

GLOBAL FORUM
On Flaring and Venting Reduction and Natural Gas Utilisation

year	LCV MJ/m³	Wobbe MJ/m³	Density kg/m³	Air req. m³/m³
2003	35.4	41.9	1.12	9.47
2004	41.8	45.1	1.33	11.14
2005	36.0	37.4	1.44	9.59

Compressors don't like liquids



Extreme example of a mixture of propane, butane, CO2 and hydrogen

Tin (max) = 50 °C

Learning Process:

Use liquid separators before entering the compressors

Heat the gas after separation

Use liquid separators at the high pressure stages

Beware of sulphur corrosion in the supply line in case of condensation

Performance Sep 29, 2008

GLOBAL FORUM
On Flaring and Venting Reduction and Natural Gas Utilisation

running on crude	UNIT 1	UNIT 2
produced kWh	114119	114899
load factor	86.45	87.04
availability	100%	100%
reliability	100%	100%
net fuel efficiency	39.9	39.9

Performance
1-1-2008 until 31-10-2008

GLOBAL FORUM
On Flaring and Venting Reduction and Natural Gas Utilisation

- **Fuel use: 49% gas, 51% crude (defective part in gas line; no stopping ordered by operator)**

- **Availability: 96.08% per unit**
- **Reliability: 98.75% per unit**

- **Electricity produced: 65 GWh**
- **Maintenance costs: US$ 349,200 = < 0.5 cts/kWh**
- **Load factor: 81%**

Learning points Gas-Diesel

GLOBAL FORUM
On Flaring and Venting Reduction and Natural Gas Utilisation

1. GD fuel sharing works: varying gas flows can be compensated for with crude oil (or other fuels)
2. Liquids should be removed from the gas, but this is state-of-the art technology
3. Large variations in gas composition pose no problems for the engines
4. A well-designed gas compression system is crucial for this application

Proof of the pudding

GLOBAL FORUM
On Flaring and Venting Reduction and Natural Gas Utilisation

Running hours:

ENGINE 1: 35,904 ENGINE 2: 36,316
(both at October 31, 2008)
(May 27, 2005: viz. 7,519 and 7.988 hours)

Lowest possible fuel costs due to use of local fuel
Flare gas is utilised with high efficiency (40% net)
(with absorption chilling 64% net)

The owner asked Wärtsilä for an extension for more than doubling the power capacity