



## Bio Energy in the Industry

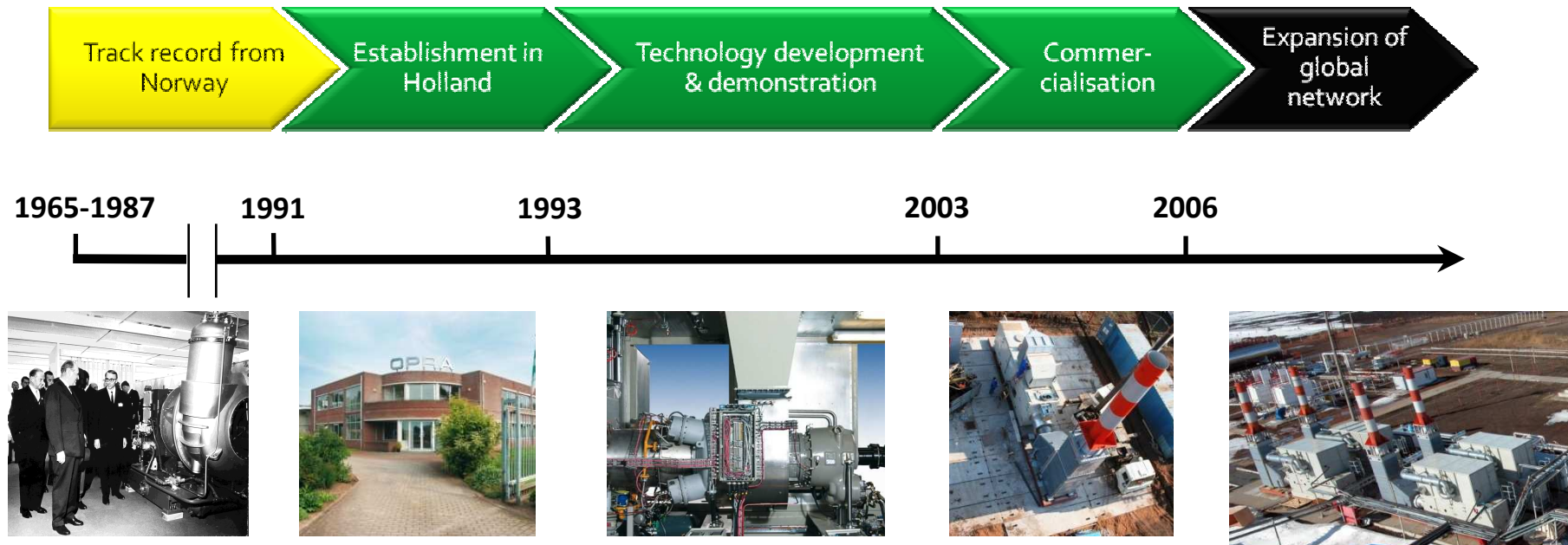


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# Agenda

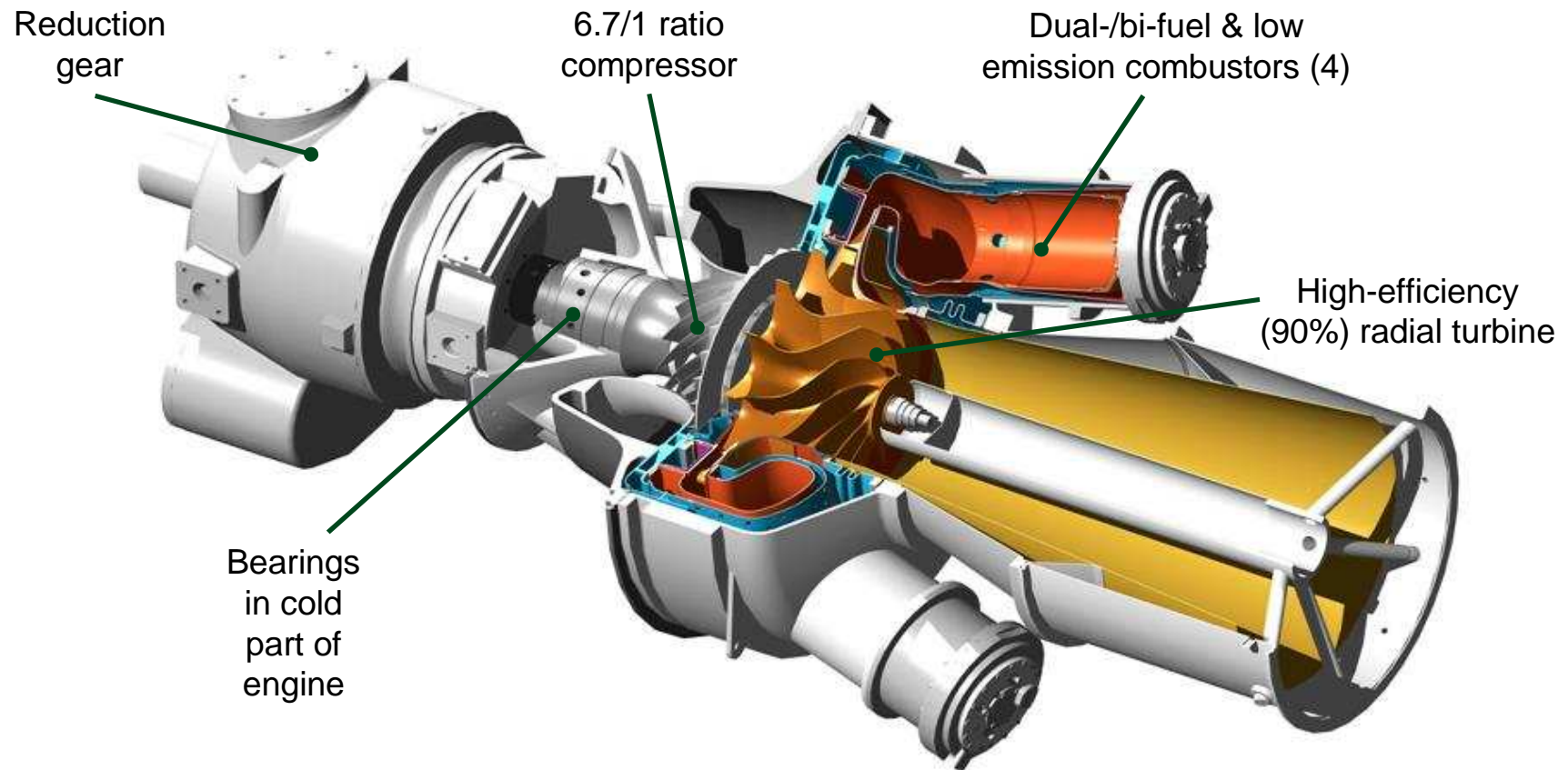
- Introduction OPRA Turbines
- OP16 design features
- Combustion technology
- OP16 Performance
- Package design
- Service & Maintenance
- OP16 applications

# OPRA's commercial success is based on 15 years of development and many years of gas turbine tradition



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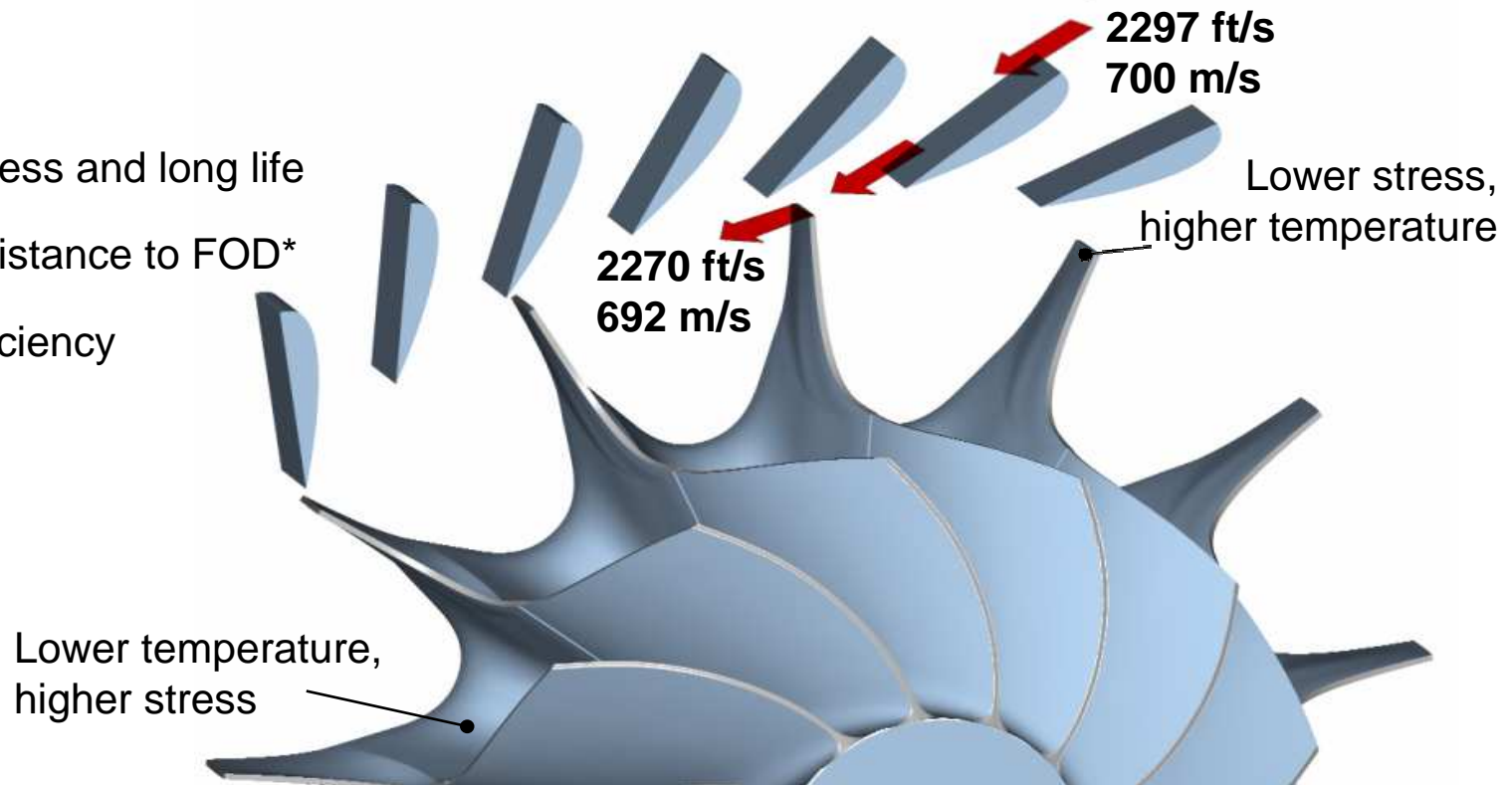
# The 1.85 MWe OP16 gas turbine engine combines the best of simplicity and high performance



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# The OP16 all radial turbine provides high efficiency and long life

- Robustness and long life
- High resistance to FOD\*
- High efficiency



\* Foreign Object Damage

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## OP16's advanced combustion systems offer low emissions and dual-fuel capabilities

- Four combustor cans for uniform heat distribution
- Maintenance friendly
- Dry low emission combustion system; <25 ppm on natural gas fuel
- Dual fuel – capable to switch under load
- Proven capability of burning a wide range of gaseous and liquid fuels

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## OPRA's combustion system enables operation on a wide range of fuels

- Pipeline gas
- Boil off gas
- "Flare gas"
- Process associated gas
- Land fill gas
- Digester gas
- Pyrolysis gas/oil
- Diesel fuel
- Kerosene

Gas flaring

# OP16 fuel capability

## Gaseous fuels

LHV	10 – 50 MJ/kg (7 - 100 MJ/Nm <sup>3</sup> )	If the LHV is below lower limit the biogas can be mixed with other fuel type to achieve required LHV
Fuel temperature	Min 6°C above dew point , max 85°C	If standard gas fuel system on gas turbine is used
	Min 6°C above dew point , max 150°C	Adjustments to be made on gas fuel system.
Water content	Max 3% mol	The gas must be unsaturated with water. If gas fuel content H <sub>2</sub> S or CO <sub>2</sub> no free water is allowed
H <sub>2</sub> S content	Max 3% vol.	The hydrogen sulfide contamination max 3% can be handled but life time of hot parts will be limited
Solid particles (dust, ash..) contamination	Max diameter 5 μm	Filtered to β ≥75
Liquid droplet contamination	Hydrocarbon and water droplets contaminants max 20 ppm	

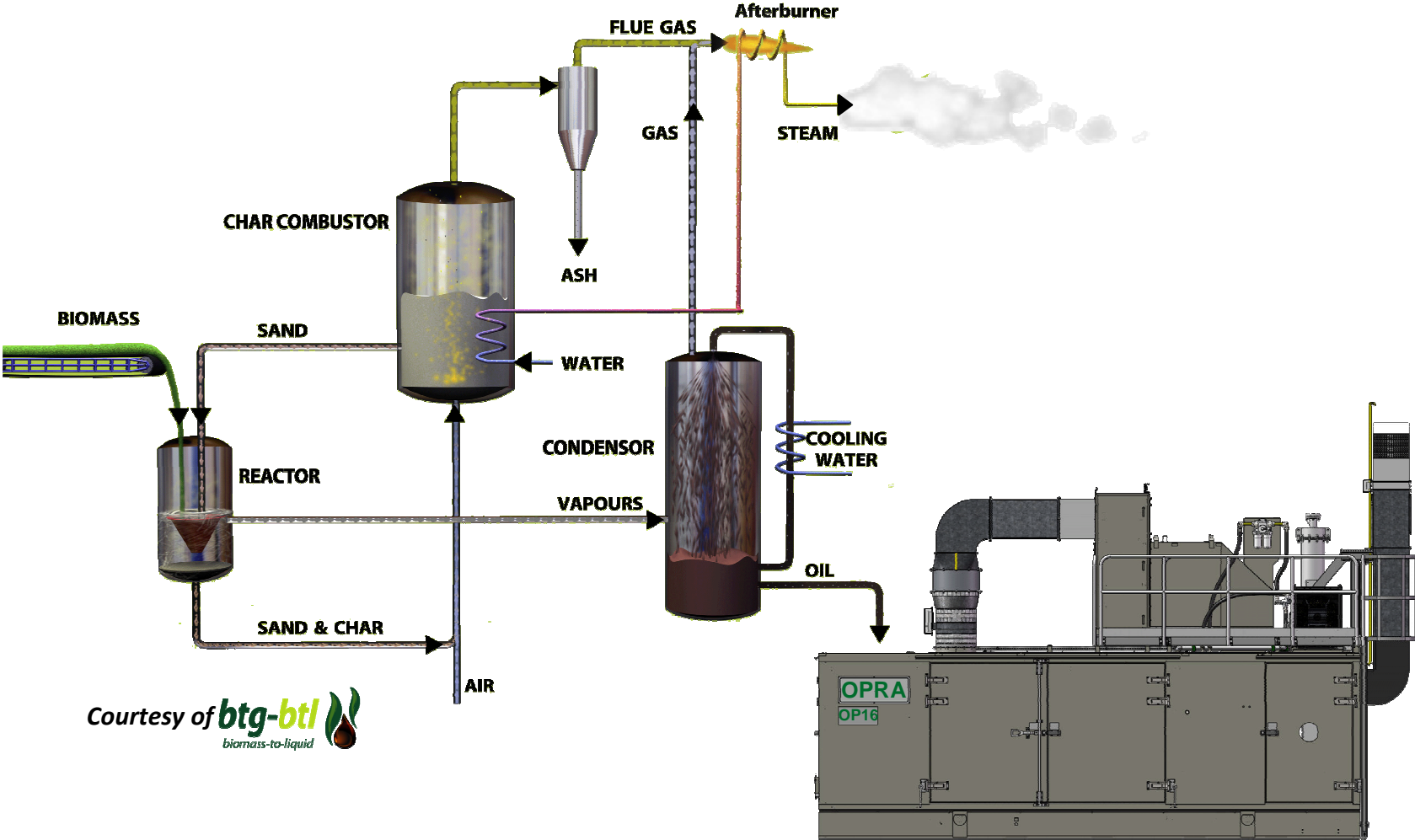


# OP16 fuel capability

## Liquid fuels

LHV	30 – 43 MJ/kg	
Density	700 – 900 kg/m <sup>3</sup>	
Kinematic Viscosity	1.3 – 6 cSt	Maximum supply temperature is 150°C
pH factor	3 - 10	
Flash Point	38 – 85°C	
Pour Point	-18 to -6°C	
Sulphur	Max 0.5% wt	The Sulphur contamination max 3% can be handled but life time of hot parts will be shorter
Contaminates and Trace Metals	Va 1 ppm Na + K 1 ppm Ca 1 ppm Pb 0 ppm Ash 0.01% wt	
Water and Sediments	Max 0.05% vol.	

# From biomass to power with OP16 combustion technology



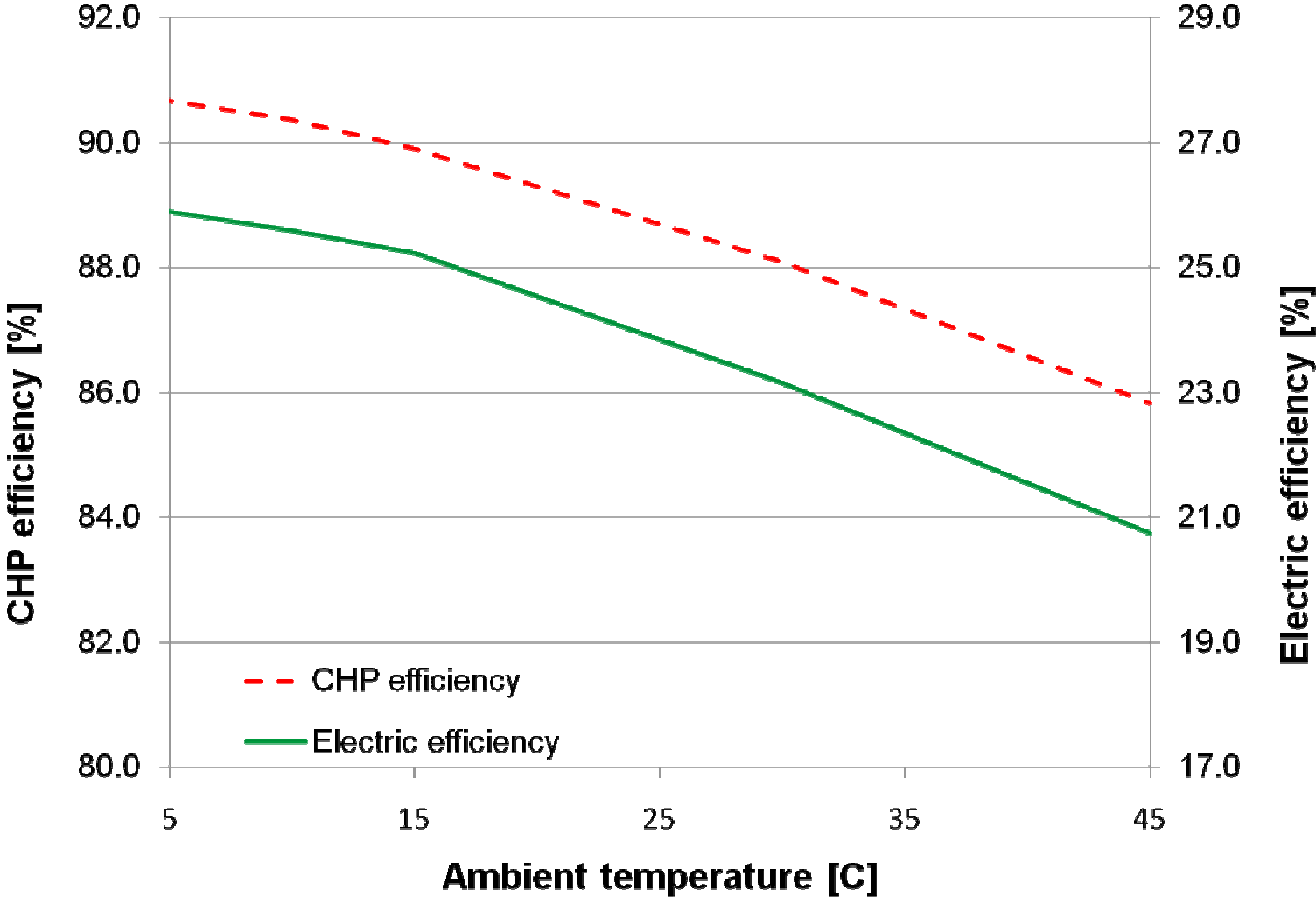
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## Performance of the OP16

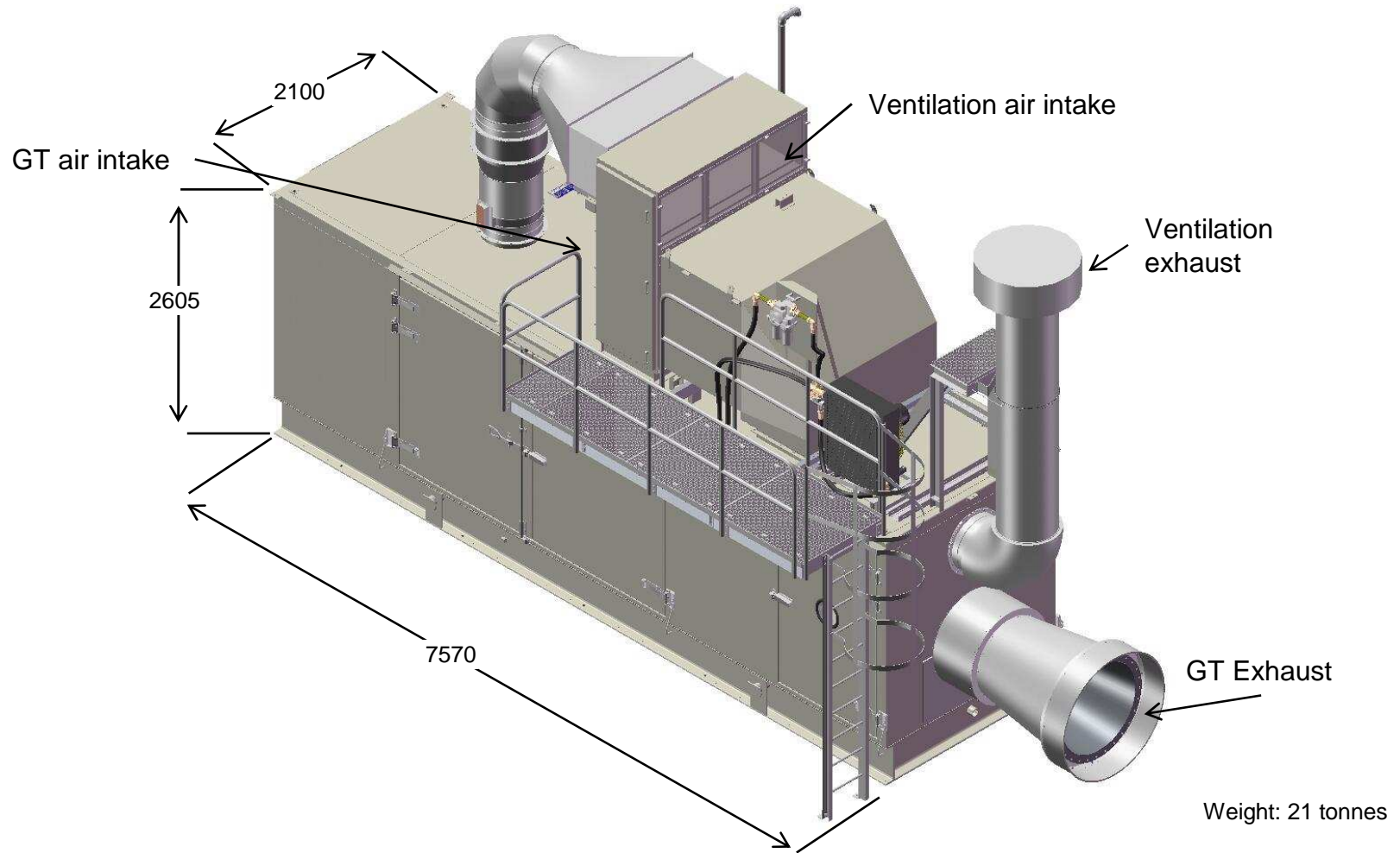
OUTPUT	1,850 kWe
HEAT RATE, LHV	13,846 MJ/kW-hr
OUTPUT SHAFT SPEED	26,000 rpm
EXHAUST FLOW	8.7 kg/sec
PT EXHAUST TEMPERATURE	560 °C

Performance given apply to ISO conditions

# Performance of the OP16



# OP16 standard package design



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# Maintenance Philosophy

## 3 TYPES OF INSPECTIONS

### A. 8,000 hr. Inspections

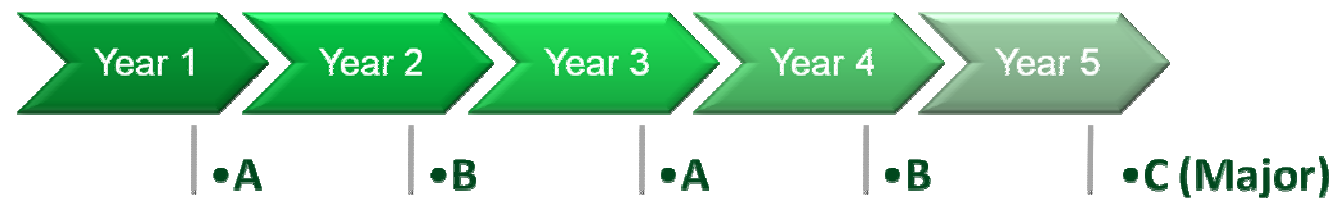
- ✓ Basic inspection of equipment
- ✓ Replacement of consumable items
- ✓ Calibration of safety critical items

### B. 16,000 hr. Inspections

- ✓ 8,000 hr. Inspection +
- ✓ Replacement of batteries

### C. Major Overhauls

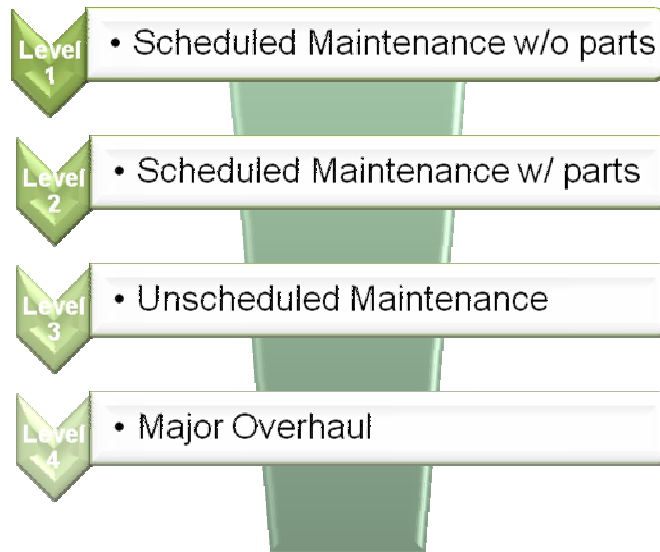
- ✓ 16,000 hr. Inspection +
- ✓ Core engine overhaul and bearing replacement
- ✓ Replacement of life expired components



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# Long Term Service Agreements

## LONG TERM SERVICE AGREEMENTS



### Option: Unit Operation

- Build / Own / Operate
- Build / Own / Operate / Transfer

### Current Contracts:

- Petrobras – Piranema FPSO
- Sevan Marine – Hummingbird Platform

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# OPRA Service Support

## OTHER SERVICES



### Spare Parts

- ✓ Consumable Parts
- ✓ Spares for instrumentation & controls
- ✓ Gas Turbine Spares
- ✓ Package Spares



### 24/7 Service Hotline



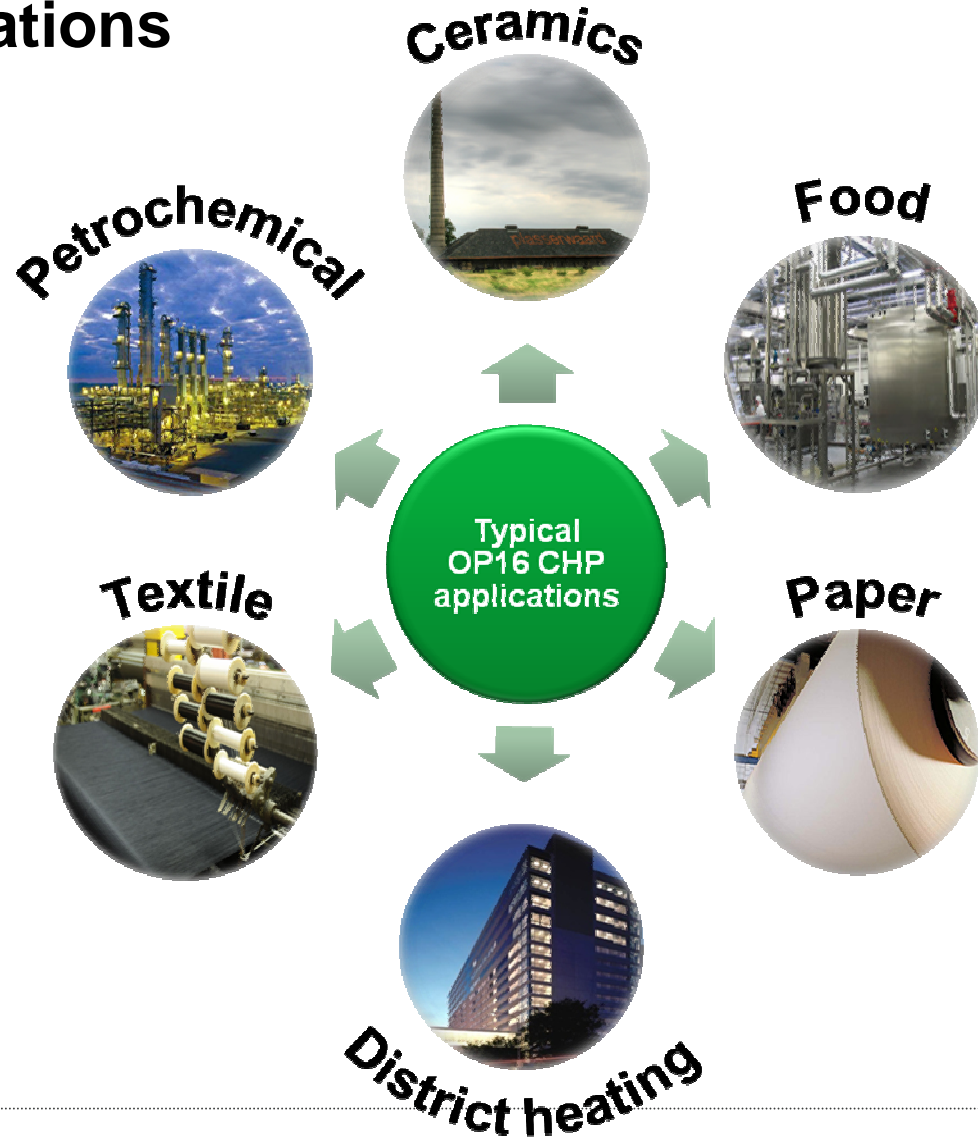
### Training

- ✓ Operation and maintenance training
- ✓ Tailor made training
- ✓ At customer site or in OPRA facility



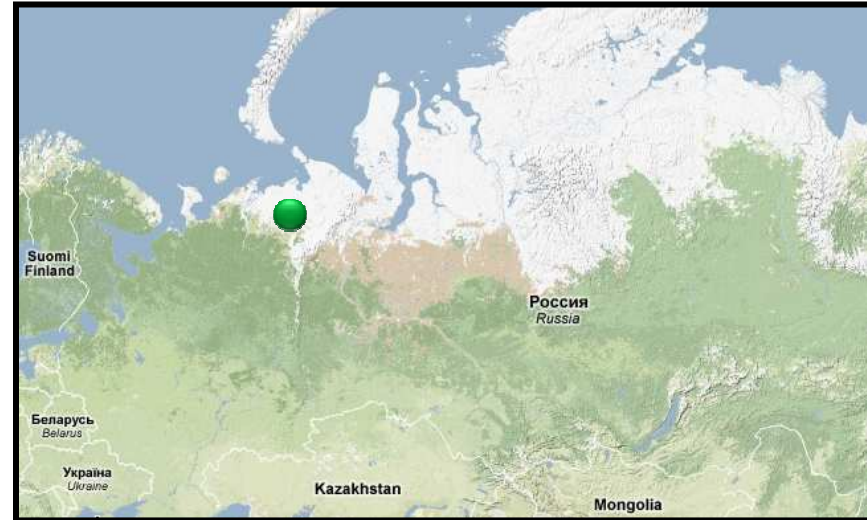
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# The OP16 can be used for a wide range of CHP applications



# Lukoil Tedinskoe Oil Field

Type of units	OP16-3A, 2 'arctic' units
Installation	CHP
Climate	-45°C ~ +40°C
Output	2x 1.85 MW <sub>e</sub> and 3.0 MW <sub>th</sub>
Voltage	6.3 kV, 50Hz
Primary fuel type	Well head gas
Combustors	Dual fuel
Control system	Remote control & management system in operator's office
Application	Hot water for facility heating and pipeline heat tracing to enable effective pumping of oil



# Petrobras Piranema Field

Type of units	OP16-3A, 3 'offshore' units
Installation	CHP
Climate	+15°C ~ +40°C
Output	3 x 1.85 Mw <sub>e</sub>
Voltage	690 V, 60 Hz
Primary fuel type	Well head gas
Combustors	Dual fuel
Certification	According to DNV's Offshore Standard DNV- OS-D101 and API-616
Application	Power generation at FPSO



# Moscow City Construction Site

Type of units	OP16-3A, 2 units
Climate	-45°C ~ +40°C
Output	2x 1.85 MW <sub>e</sub>
Voltage	10.5 kV, 50 Hz
Primary fuel type	Natural gas
Combustors	Gas fuel
Application	Power generation for construction site of Moscow International Business Centre project.

