SOGIC 2018

May 8, 2018 | Hyatt Regency, Calgary, Alberta

SGT-A45 Mobile Unit

Fast Power – Superior value – Trusted technology

Brian Nolan, Product Manager

The Siemens Gas Turbine portfolio – SGT-A45 using Rolls-Royce Aero Engine Technology

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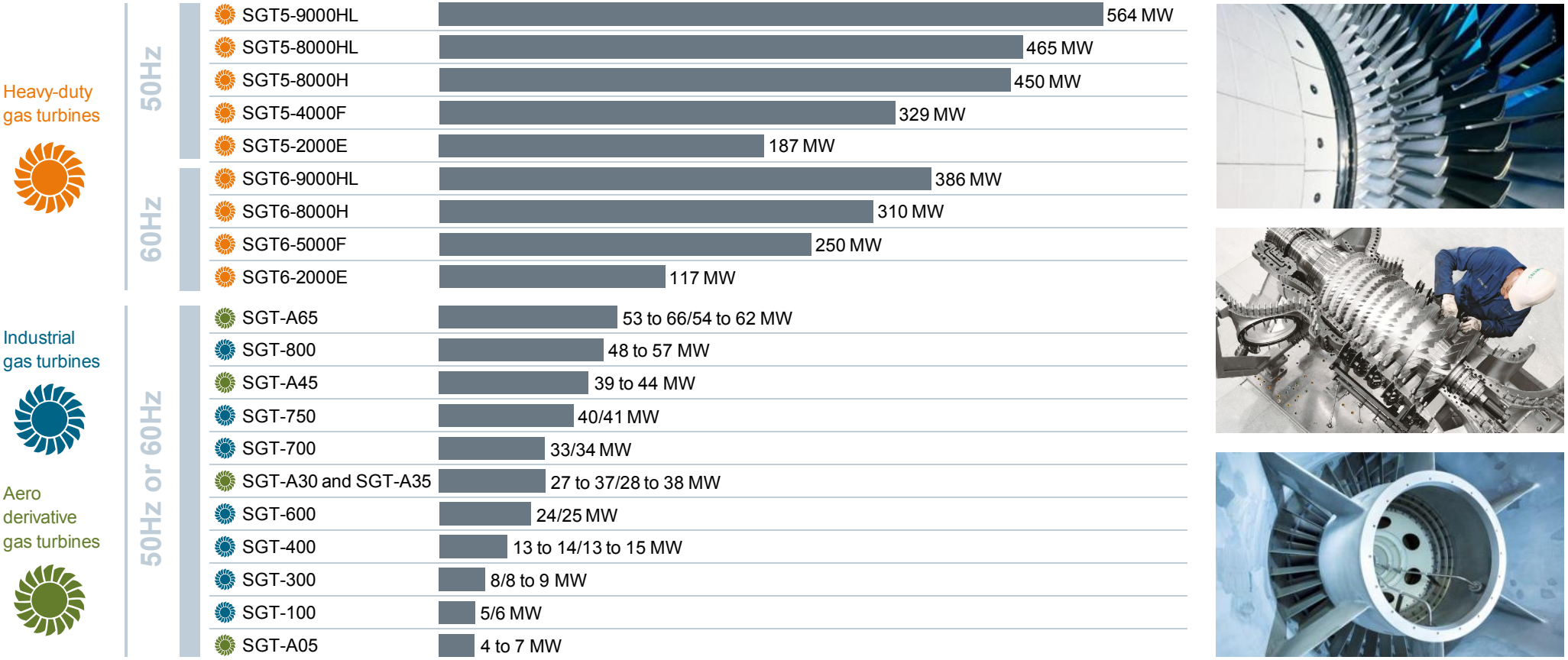

Mobile Gas Turbines serve a fast growing Power-Gen market – Driven by Customer needs for Fast Power

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Low electrification

Population growth

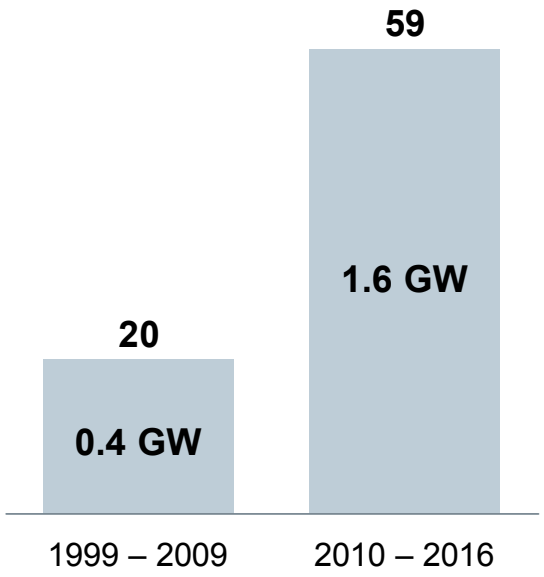
GDP[1] growth

+

Fast Power

Annual sales worldwide

Mobile Gas Turbines (# units)



Application drivers

- Weak or unreliable infrastructure
- Bridging power
- Natural events
- Political unrest
- Renewable additions
- Market liberalization
- Retirement of old plants
- Extended outage of other power plants
- Seasonal grid support
- Ability to relocate (mobility)
- Remote sites (e.g. mining, fracking)
- Fuel availability (e.g. flare gas)
- … and more

1 Gross Domestic Product | **Source:** McCoy Power Reports; Siemens data

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Siemens introduces the SGT-A45 mobile unit

Fast Power – Superior value – Trusted technology

SGT-A45 Mobile Unit –
Fast Power – Superior Performance – Trusted technology

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Fast Power

- 2-weeks installation
- Mobile by road, air or sea
- Minimal site interfaces and preparation

Superior value in operation

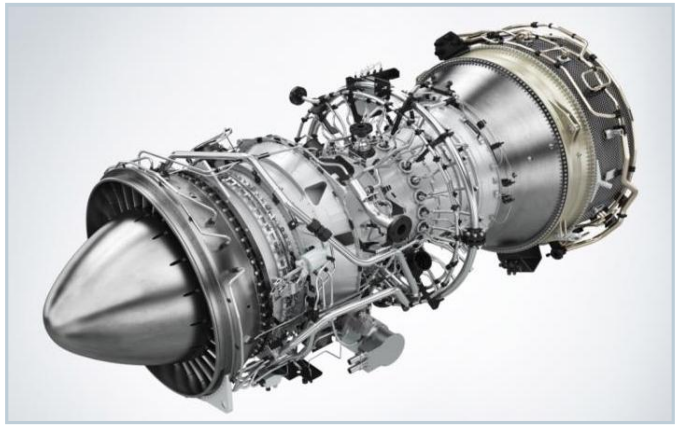
- OPEX savings with high fuel efficiency
- Liquid and gas fuel with same service interval
- Proven turbomachinery in industrial package

Cost-effective power solution

- 44 MW_e (ISO) with outstanding power density
- CAPEX savings with fewer units (US$/kW)
- Performance optimized for hot climates

Flexible, dependable technology

- 50 Hz or 60 Hz
- Emissions as low as 25 vppm NOx
- Fast start (<8 mins) and no “hot lock-out”



SGT-A45 Mobile Unit – With Rolls-Royce Aero Engine Technology

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Gas Turbine manufacturing

Montréal, Canada

Package manufacturing

Houston, USA

SGT-A45 Mobile Unit

44 MW_e

Gas Turbine pedigree

Rolls-Royce Trent 800
28 m flight hours

Siemens SGT-A65 TR (Industrial Trent 60)
1.5 m service hours

The SGT-A45 superior performance drives better economics – More power – Less units – Less fuel

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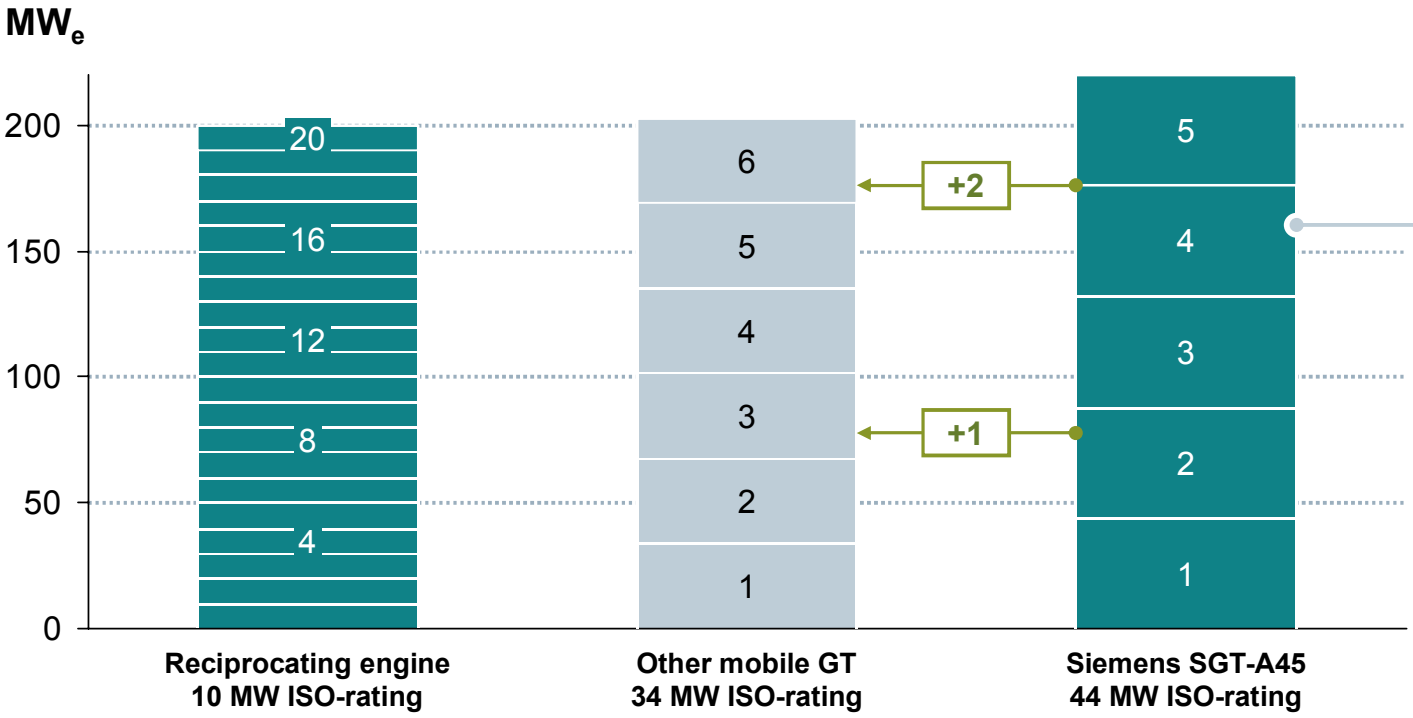
Power Plant output @ ISO – 60 Hz performance without water injection



150 MW power plant
Annual fuel savings[1]

US$ **1,000,000** gas fuel
4,500,000 liters Diesel –
Due to higher efficiency

1 Compared to other mobile gas turbine Based on 150 MW plant output. Gas fuel price 6 $/MMBTU 8,000 hrs operation per year

SGT-A45 Gas Turbine – With Rolls-Royce Aero Engine Technology

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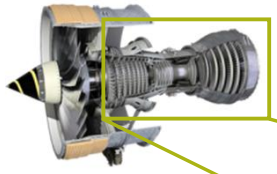
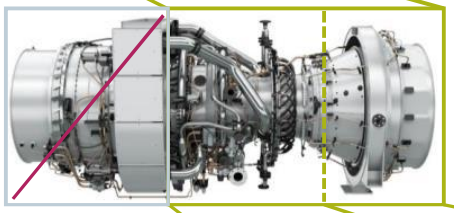


Rolls-Royce Trent 800



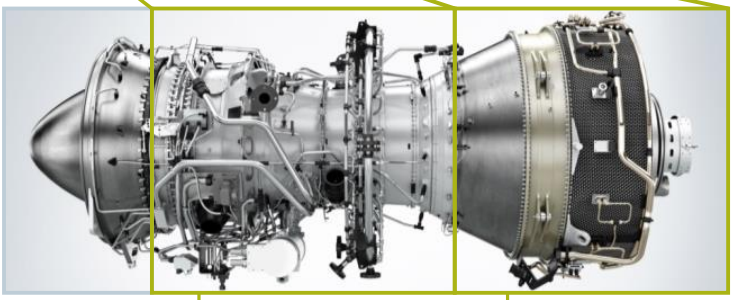
SGT-A65
(Industrial Trent 60)
66 MW

LP booster removed

Common technology platform
Extended portfolio

SGT-A35
(Industrial RB211-GT30)
38 MW

Rolls-Royce MT30 Marine
36 MW



SGT-A45
44 MW

SGT-A65 Engine Core

Free Power Turbine
Derived from Industrial/Aero/Marine Trent

SGT-A45 Mobile Unit

44 MW_e

Gas Turbine pedigree

Rolls-Royce Trent 800
28 m flight hours

Siemens SGT-A65 (Industrial Trent 60)
1.5 m service hours

SGT-A45 heritage – SGT-A65 (Industrial Trent 60) – Fleet experience in all regions

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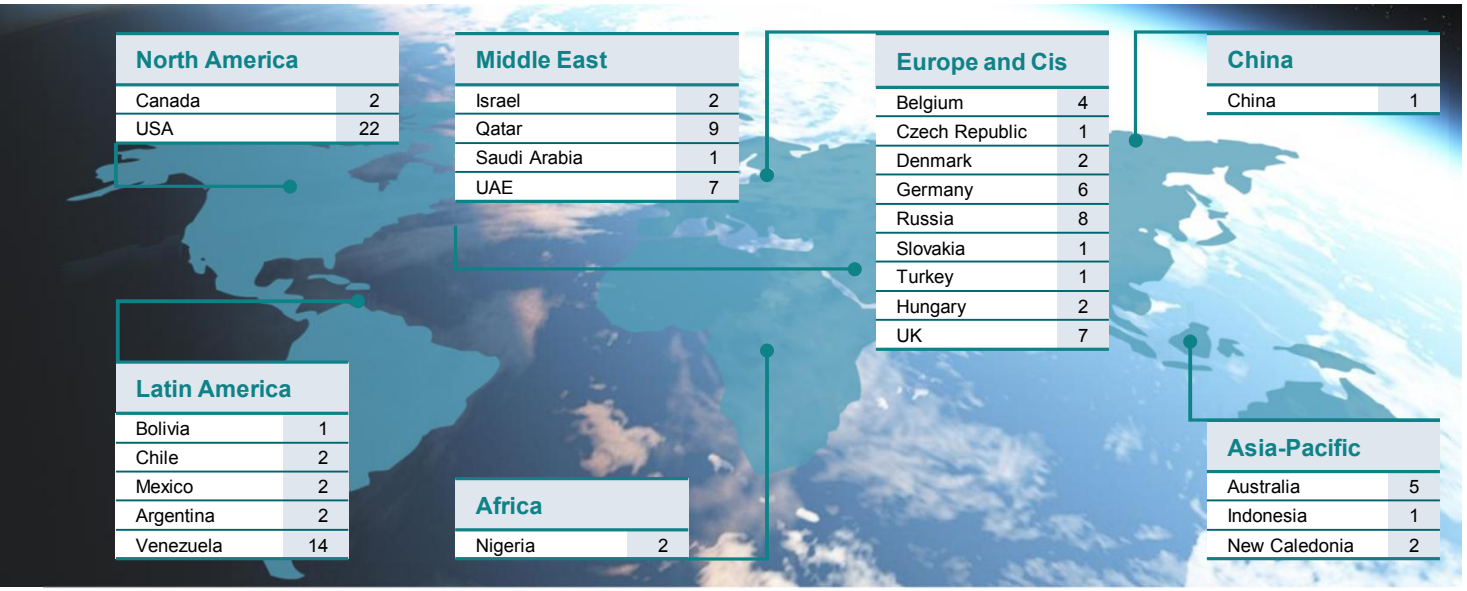

115 SGT-A65 units sold

1.65 Million
SGT-A65 operating hours

There of **100** units for Industrial Power Generation

15 units in Oil and Gas applications

Project/ Country	Bayonne Energy Center, New Jersey, USA
Application	>500 MW peaking power for New York City
Technology	8x SGT-A65 WLE with ISI 2x additional units ordered in 2016
Operation	2012
Benefits	• 500 MW in 10 mins (non-spinning reserve) • Unlimited cycles per day, no lock-out • Compact footprint • Best in class efficiency • Very high availability and start reliability

SGT-A45 Performance Ratings – 60 Hz – Significantly more mobile power

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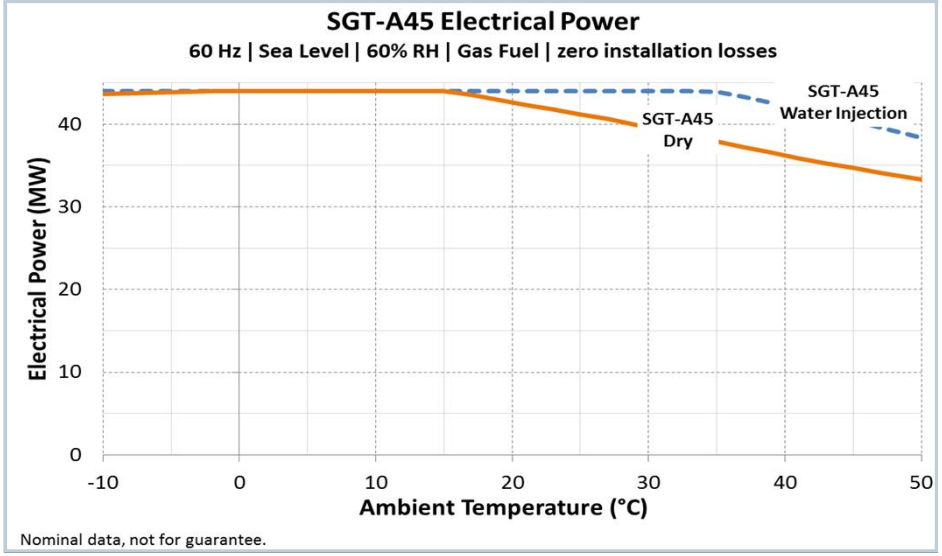
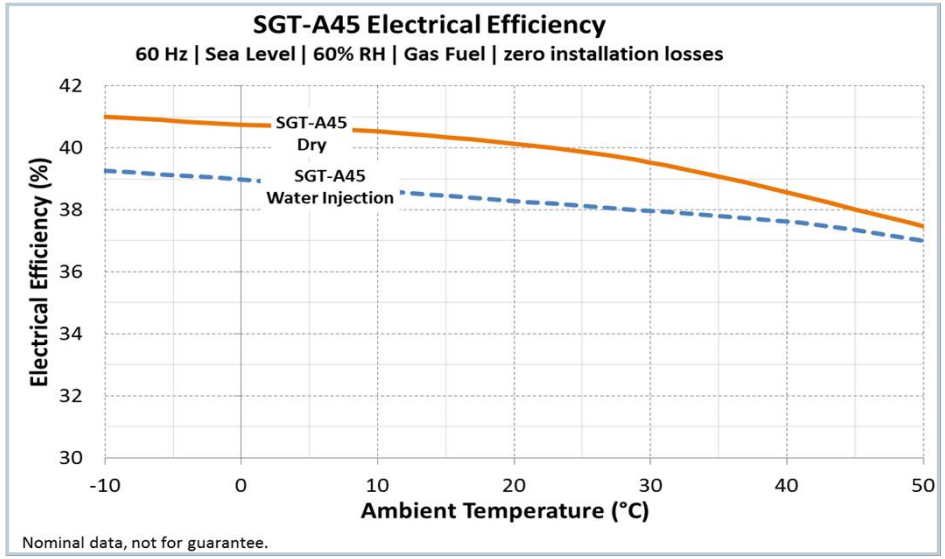
60 Hz generation – Power and Efficiency





- High fuel efficiency minimizes life cycle cost
- Water injection (optional) allows constant output @ 44 MW_e to almost 40°C
- Dual Frequency – same hardware can switch between 50 Hz and 60 Hz

1 Nominal data, not for guarantee

SGT-A45 Mobile Unit – Typical 3-trailers Layout

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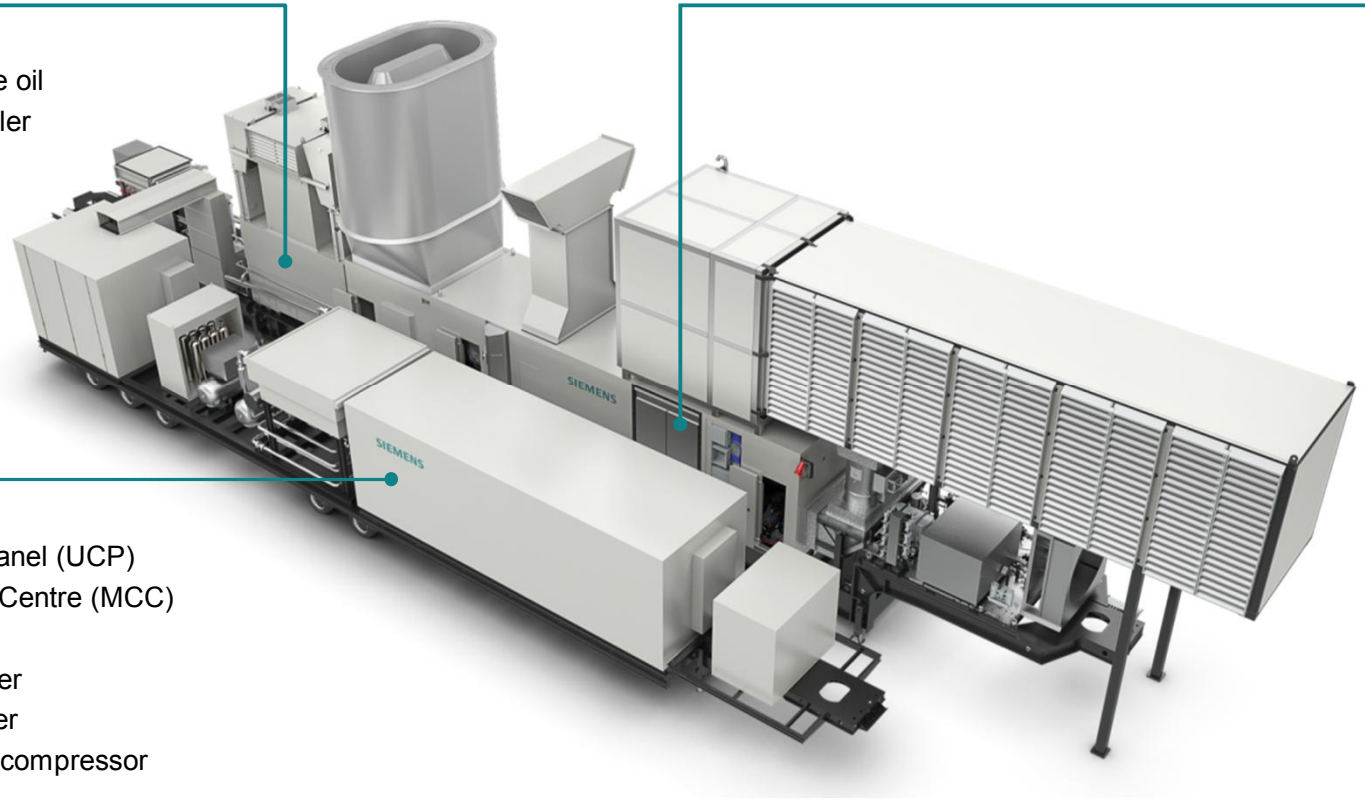
Trailer #1

- A/C generator
- Generator lube oil
- Generator cooler

Trailer #2

- Gas Turbine
- GT lube oil (synthetic)
- Air inlet silencer
- GT enclosure ventilation
- Fire protection
- Gas Fuel metering
- Liquid fuel/water metering
- Water wash
- Air-blast cooler (GT oil)



Trailer #3

- Switchgear
- Unit Control Panel (UCP)
- Motor Control Centre (MCC)
- UPS
- Aux transformer
- Purge air cooler
- Instrument air compressor

Non-trailerized (ship loose)

- Air filter
- Exhaust stack
- GT bleed air silencer

Reference Plant 175 MW (ISO) – 4 x SGT-A45 units

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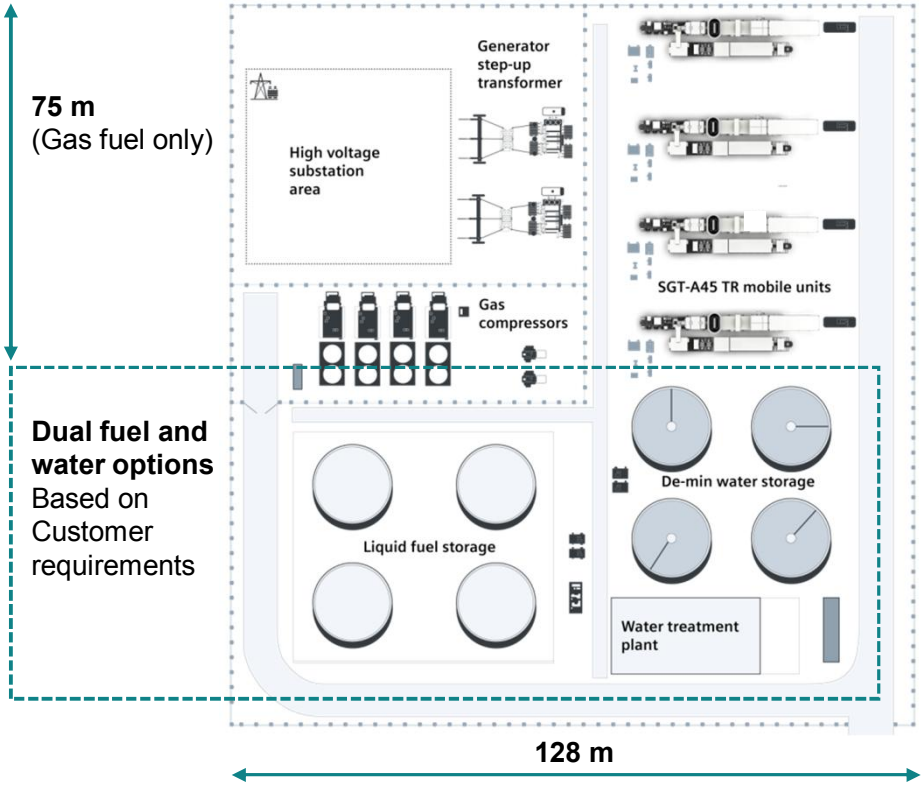
175 MW
With 4 units

2 Weeks
Gas turbine installation

Tailored solution
Flexible balance of plant scope



Truck access for GT installation
One side only – Balance of Plant installation can proceed undisturbed in parallel

175 MW (ISO) in 1 hectare (2.5 acres)
(Gas fuel only without water injection)

High mobility options for Balance of Plant

Maintenance Plan – SGT-A45 Mobile Unit

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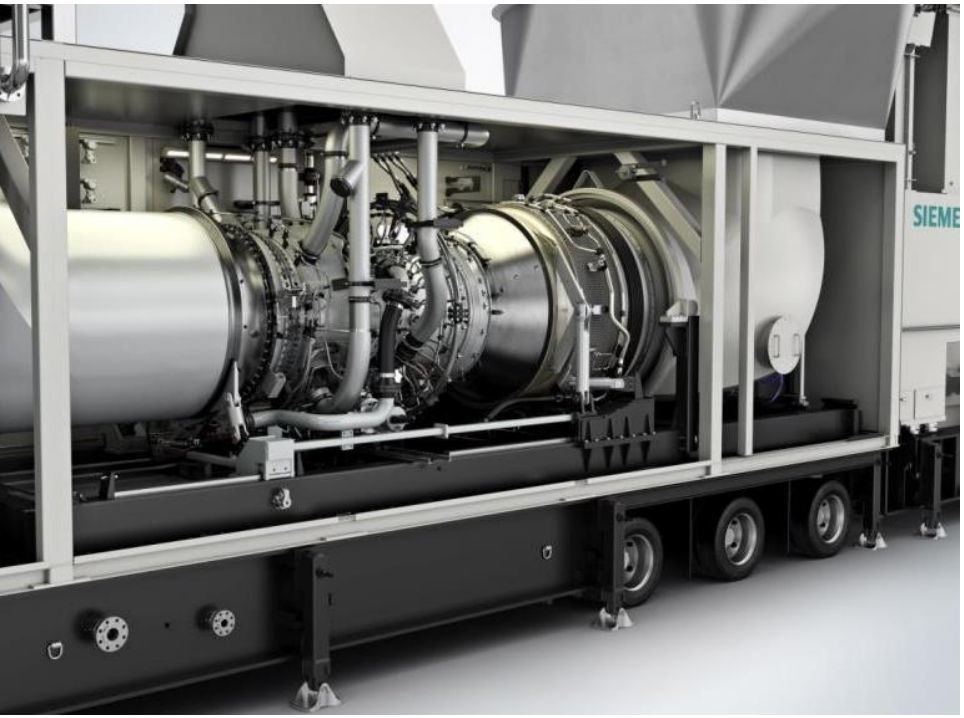
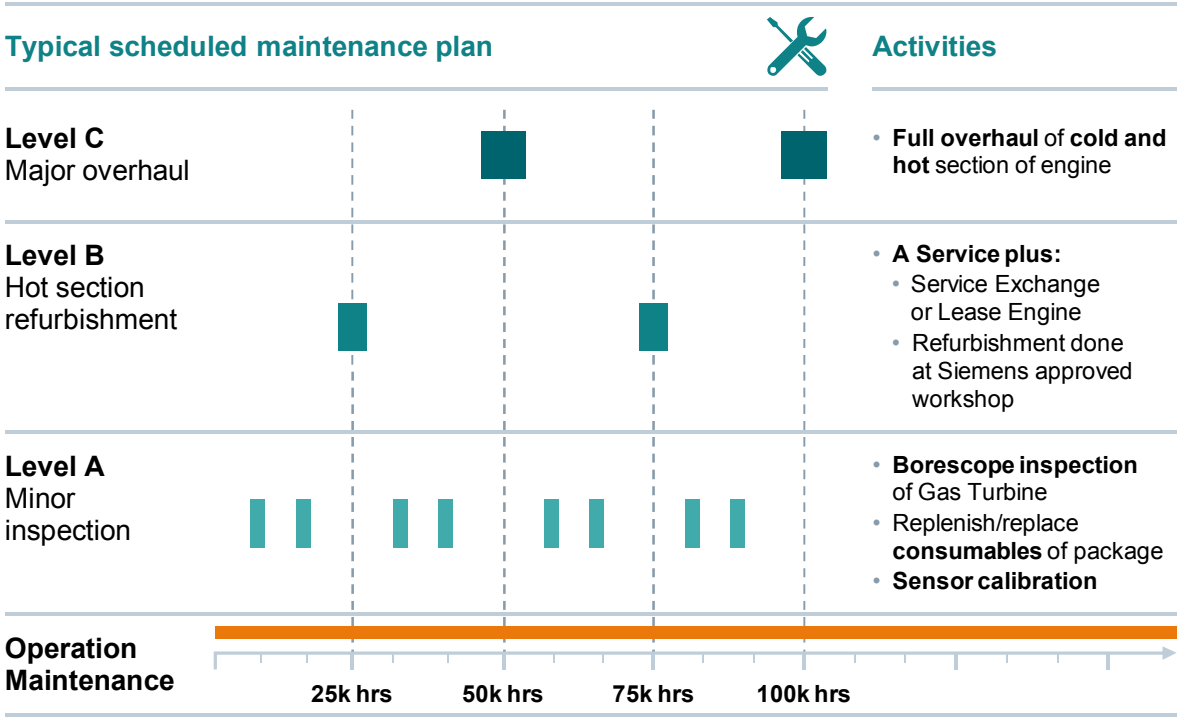


Lightweight aero-derivative core engine facilitates rapid exchange



SGT-A45 has no reduction in time between overhauls for operation on liquid fuel

SGT-A45 mobile unit – Transportable by road, air or sea

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SGT-A45 Mobile Unit

Fast Power
2-weeks installation

Superior value
- More power
- Less US$/kW
- Less fuel

Trusted technology
Proven, flexible turbomachinery

https://www.youtube.com/watch?v=r4H_j-DoSaY

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Industrial gas turbine SGT-750

Value for customers

siemens.com/gasturbines

The Siemens gas turbines portfolio:
The right engine for every requirement

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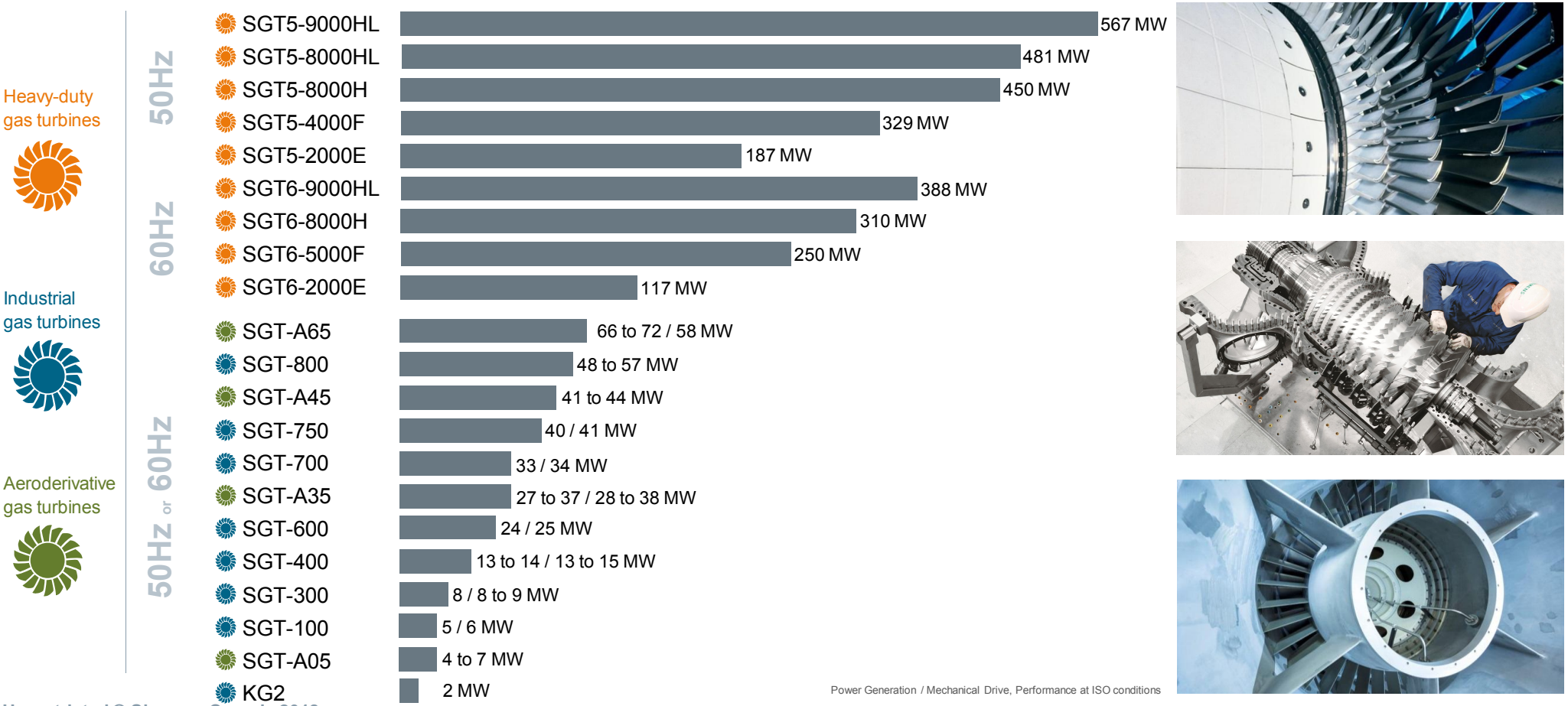

Power Generation / Mechanical Drive, Performance at ISO conditions

Siemens gas turbine installations

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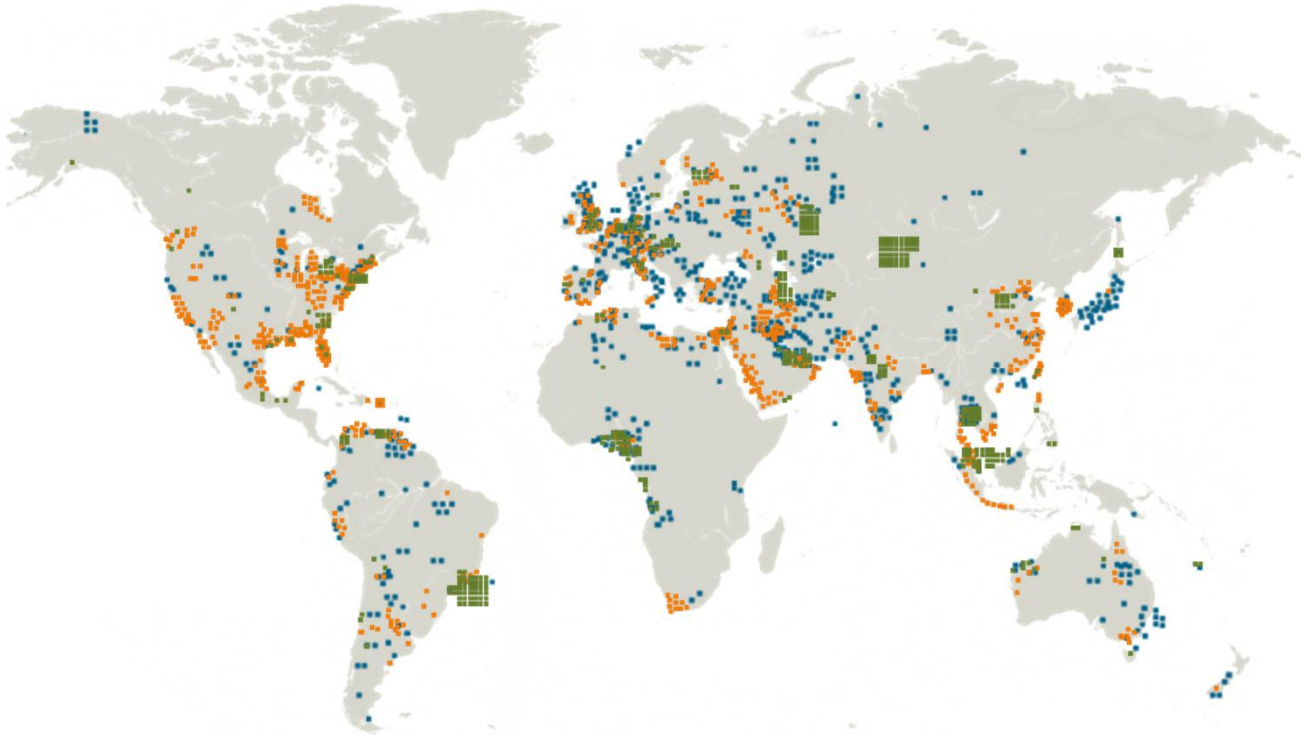
Heavy-duty gas turbines

Industrial gas turbines

Aeroderivative gas turbines



more than **60** countries

more than **6,900** installed gas turbines

Innovative and well-matched products to your requirements

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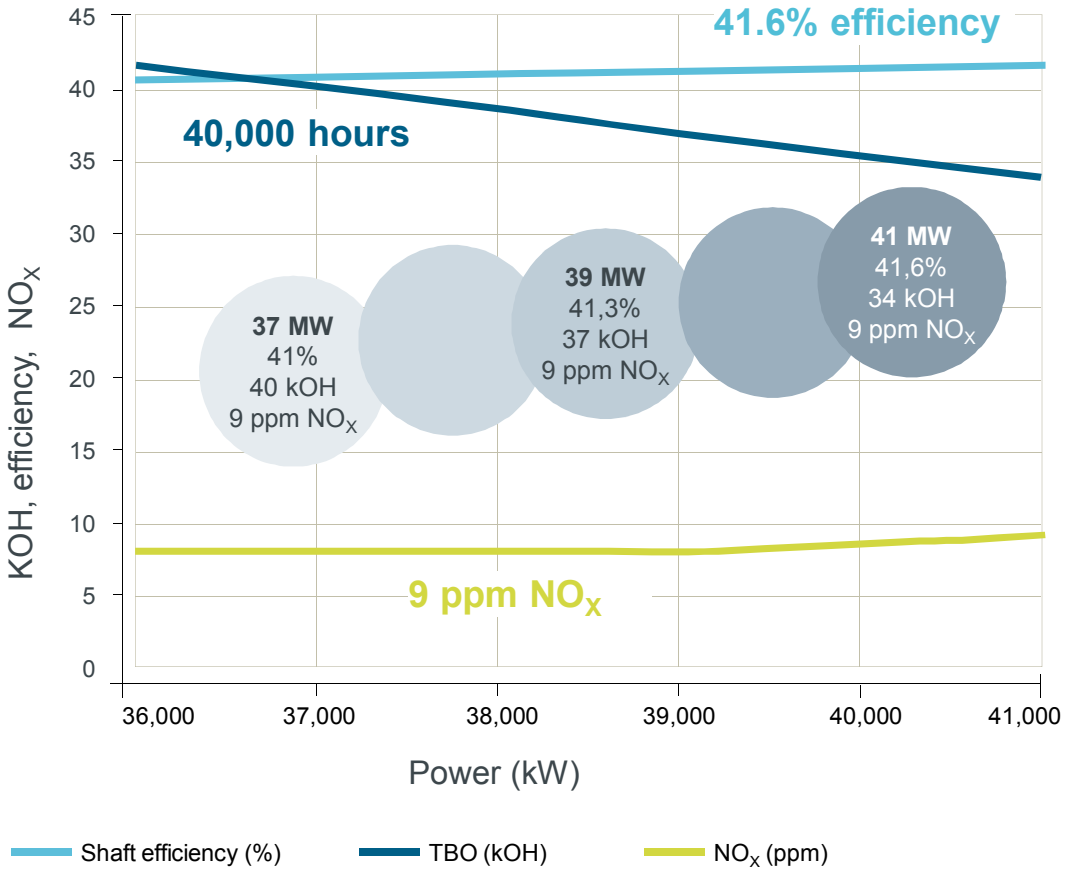
Best-in-class performance	• High lifetime profitability • Highest performance even at extreme conditions • Best-in-class performance also on part-load operation
Highest flexibility	• Fast start capability • Dual fuel with online switchover capability • Wide fuel range • Twin-shaft gas turbine with generic driver
Excellent service-friendliness	• Service-friendly design - low maintenance cost • Maximized uptime – 17 maintenance days in 17 years • Fast gas generator exchange • Maintenance on-site or at local service workshop
Environmentally friendly	• Low environmental footprint • Lowest emissions on the market with single digit NO_x • Fourth generation DLE combustion system

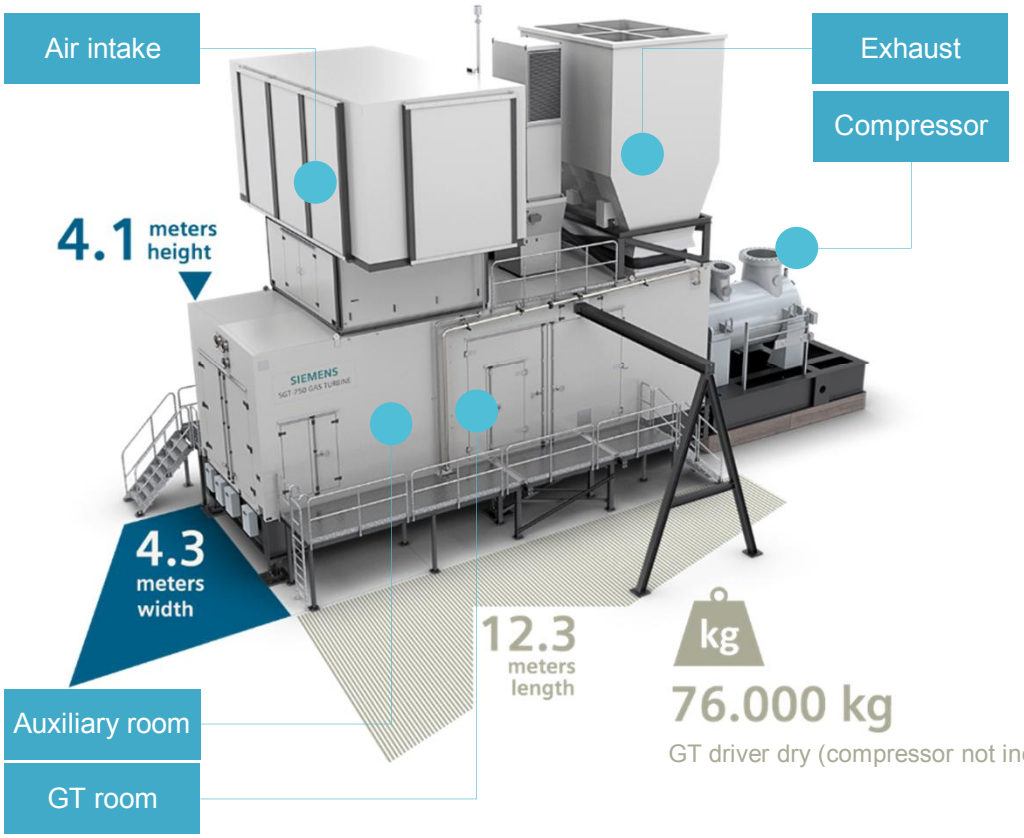
Maximized customer satisfaction with flexible rating – Best in class even at part load



Flexible offers to maximize customer satisfaction:

- **Highest up-time**
  → 40,000 hours between overhauls
- **Lowest emissions in the market**
  → 9 ppm NO_X over a wide load range
- **Highest efficiency**
  → close to 42%
- **Guaranteed power and efficiency over a long time of period**

SGT-750 package



Power generation and mechanical drive use the same driver:

- Compact
- Self-supporting
- Pre-assembled
- Modular design
- Single lift available
- Small footprint and lightweight construction

Dimensions are approximate and exclude inlet filter housing and exhaust stack.
For mechanical drive, driven equipment is excluded.

SGT-750 industrial gas turbine core engine – for power generation and mechanical drive

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1 Compressor

- 13-stage axial flow compressor
- Two variable guide vanes
- Axial blade attachments for easy blade removal
- Borescope ports on all stages

2 Rotor

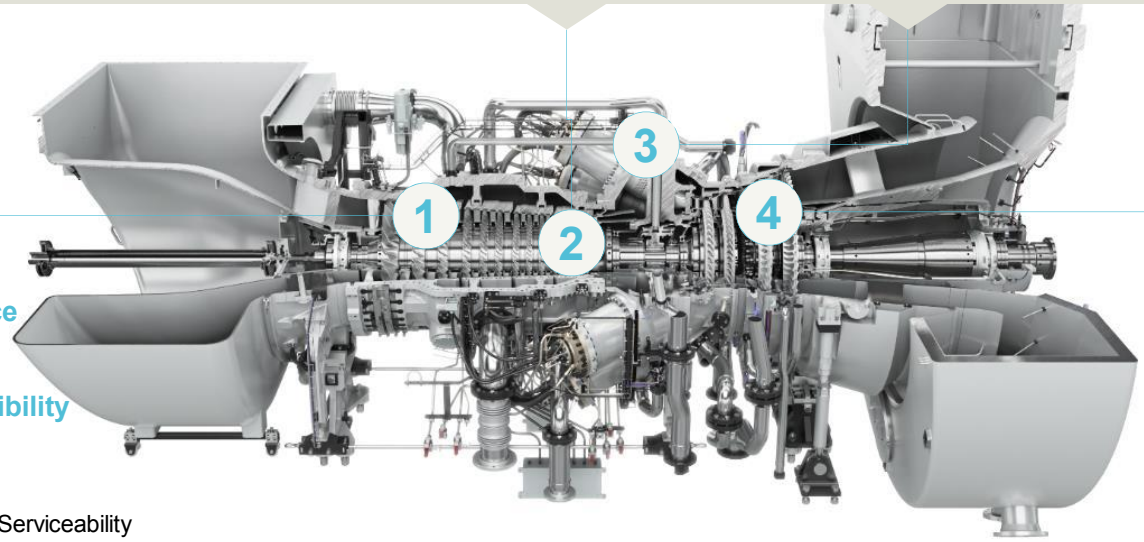
- Twin-shaft design
- Two-stage compressor turbine
- Electron beam-welded for maximum stability

3 Combustion

- Dry Low Emissions (DLE)
- Single-digit NO_X capability
- 8 cans with transition ducts
- Dual fuel capability

4 Turbine

- Two-stage free power turbine
- Nominal speed of 6,100 rpm (3,050 to 6,405 rpm for MD)
- Different matching options for optimized performance



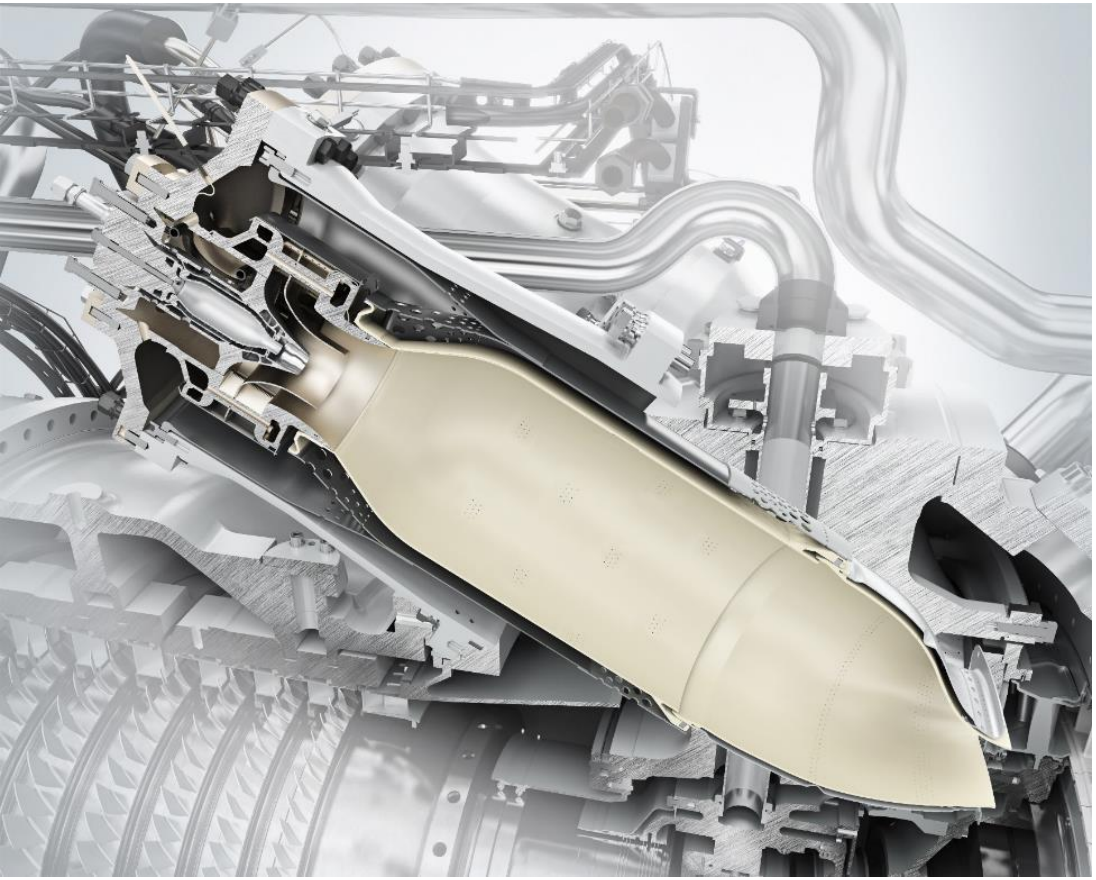
- Best-in-class performance
- Maximized uptime
- Fuel and operational flexibility
- Pitch & Roll capability

Flexibility Performance Serviceability

Infra Red Cameras

- mapped with infrared (IR) cameras during engine delivery test and during regular scheduled inspections
- gives online blade temperature measurements

4th generation DLE delivers outstanding fuel diversity



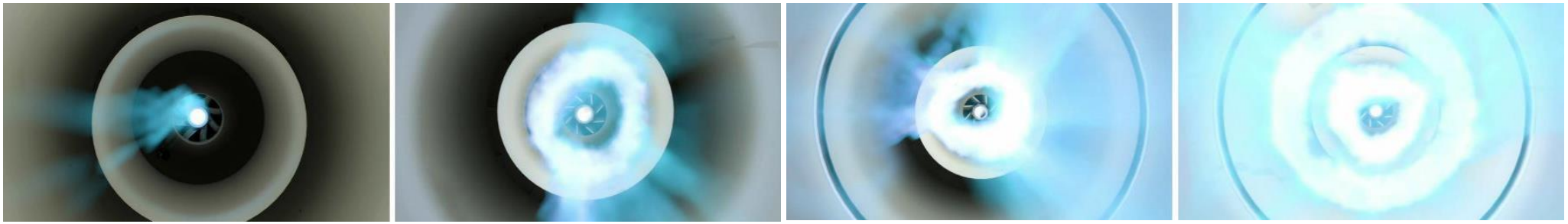
The SGT-750 combustor consists of eight cans with transition ducts and burns both gaseous and liquid fuels.

Simple and stable DLE system:

- Low NO_X with gas and liquid fuel
- On-load fuel changeover capability
- Insensitive to variations in ambient temperature
- Tuning (mapping) of the DLE system is not required
- No burner staging allows for rapid load changes

The fourth generation DLE combustion system gives lowest emissions on the market over a wide load range.

Fuel flexibility continuously improved



- Wide gas fuel specification for DLE
- Not sensitive to changes of gas composition
- Maintaining very low emissions
- Robust and fuel-flexible dual fuel DLE system with online fuel changeover
- Wobbe index range 22 – 60 MJ/nm^3 proven

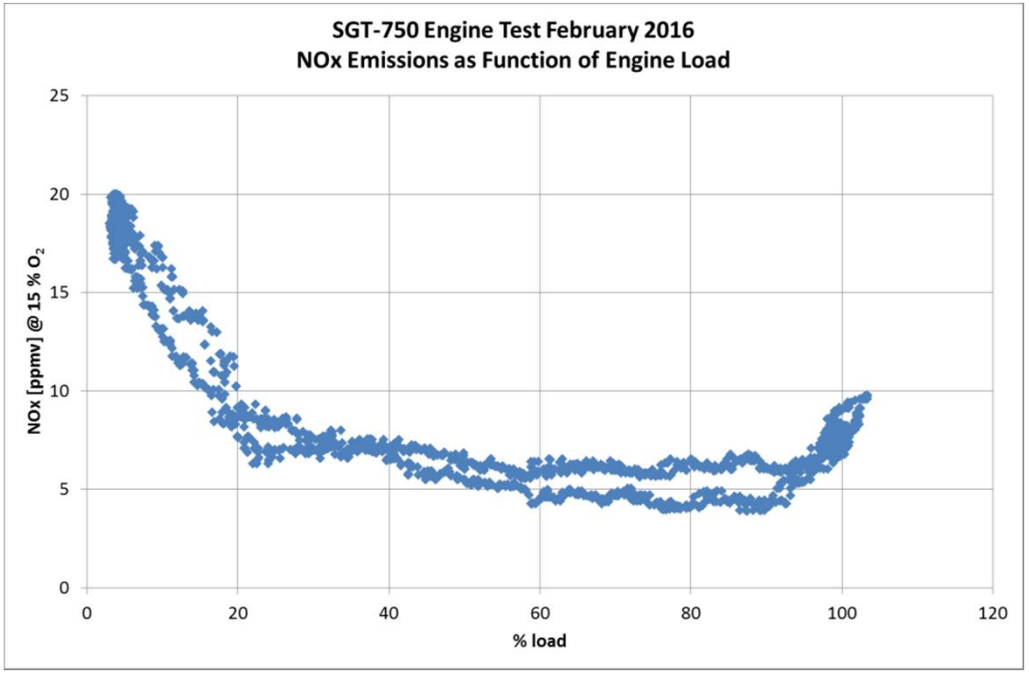
Gas Fuel Constituents	Max mole %	Max mole %
Methane, CH_4	100	50
Ethane, C_2H_6	30	0
Propane, C_3H_8	30	0
Butanes and heavier alkanes, C_4+	15	0
Hydrogen and carbon monoxide, H_2 + CO	15	0
Inerts, N_2/CO_2	40	0
Hydrogen sulfide H_2S	50/40	0

Market-leading emissions over a wide load range

Gas fuel type	Natural gas	Diesel No.2
20 – 100% load NO_X @ 15% O_2	≤9 ppmv	≤25 ppmv*
50 – 100% load CO @ 15% O_2	≤25 ppmv	≤25 ppmv

*water injection

- Single digit NO_X over a wide load range
- Wide turn down range 50 – 100% (CO below 25 ppm)
- Stable DLE system without need for staging or ”seasonal mapping”



Optimized maintenance concept – 17 maintenance days in 17 years

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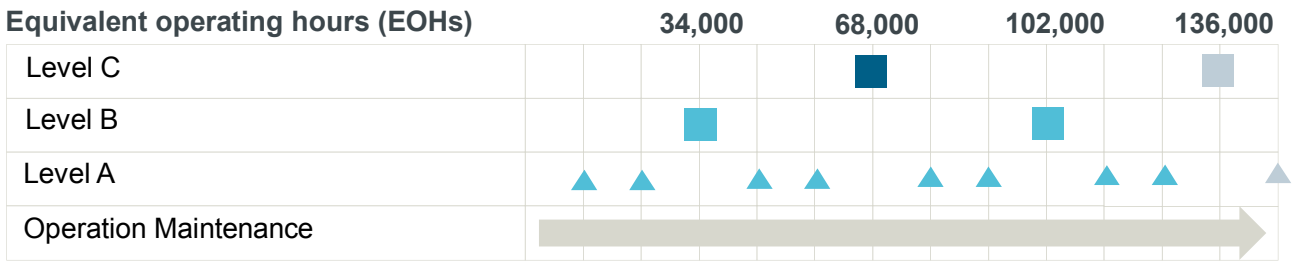
Maintenance plan schedule



Downtimes for on-site or off-site (using exchange gas generator) maintenance

On-site maintenance - 48 days: On-site inspections AF >97.5%

- 1 day A-inspection
- 12 days B-inspection
- 16 days C-inspection

Off-site maintenance with gas generator (GG) exchange AF <98%

- 1 day A-inspection
- 2 days B-inspection (GG Exchange)
- 5 days C-inspection (GG Exchange)

Core maintenance features

- Package designed for fast gas generator exchange
- 24-hours gas generator exchange from load to load
- Rollout tools included
- Instruments are integrated on gas generator module – no need for disassembly
- Lifting devices included
- Instruments are integrated on gas generator module – no need for disassembly
- Quick couplings

1) Equivalent operation hours; 2) Original Equipment Manufacturer; 3) Stress factor

Reference: Kaltex Altamira

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Combined heat and power

Customer: Energia MK KF, S.A. de C.V. (Grupo Kaltex)

Country: Mexico

Plant type: Textile

Challenge

- Very competitive international market
- Kaltex needed to reduce its electricity bill and the cost for steam production
- Company's prior power source & process called for power from the public utility grid & steam from gas fired boilers – 2-phase process was prone to delays and inefficiencies resulting in loss of competitiveness

Technology

- 1 x SGT-750 Gas Turbine - Generator Package

Solution

- High-efficiency solution based on one SGT-750 gas turbine with the added value of providing a power island including HRSG, electrical and controls for the plant, including engineering and a comprehensive long term service agreement adapted to customer needs
- Solution allows Kaltex to wheel power to other locations and to take advantage of high reliability resulting in lower process backup costs

Benefits

- Reliability of power & steam source helps for competitiveness with reduced downtime
- Reduced fuel costs using less expensive natural gas
- Market advantage with capabilities of combined heat and power
- Generates process steam for manufacturing synthetic textile fibers
- Two-third of the electric power fed into the grid
- Full load operating mode in just 10 minutes; electrical efficiency of 38,7 %

Oil & gas and industrial applications services
Backup services

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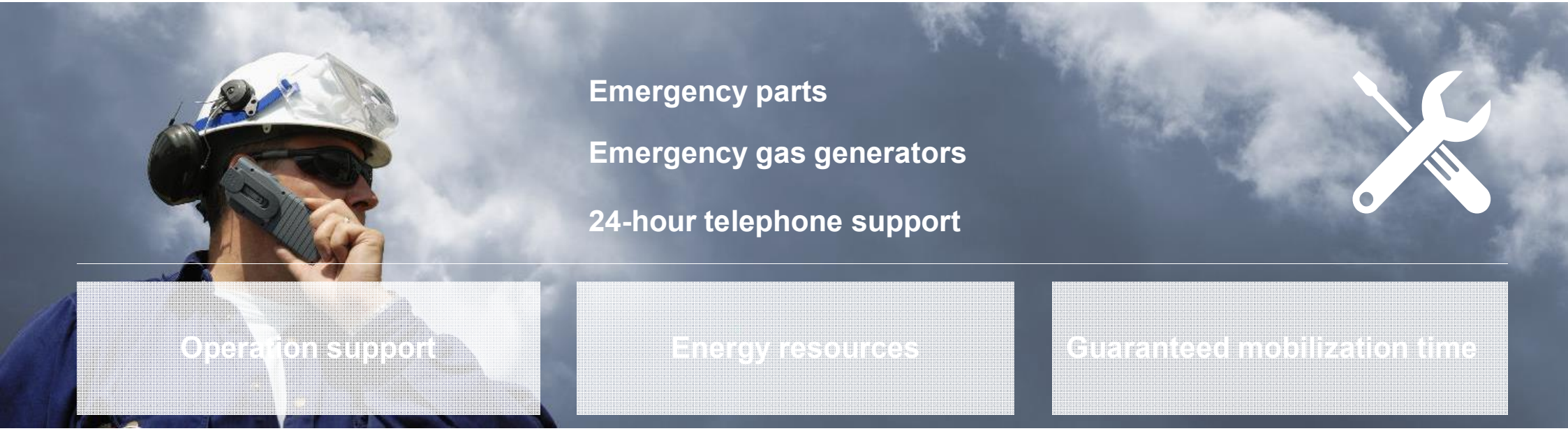

Emergency parts

Emergency gas generators

24-hour telephone support

Operation support	Energy resources	Guaranteed mobilization time
▪ 24/7 emergency phone ▪ Trouble-shooting via remote access ▪ Remote monitoring systems	▪ Service specialists ▪ Tools & parts ▪ Core engines & modules	▪ Personnel, 24 hours ▪ Tools, parts, engine to site or to international freight forwarder within less than 72 hours

Innovative and well-matched products to your requirements

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- High lifetime profitability
- Highest performance even at extreme conditions - 41MW @ >41% efficiency
- Best-in-class performance also on part-load operation

Best-in-class performance

- Fast start capability
- Dual fuel with online switchover capability
- Wide fuel range
- Twin-shaft gas turbine with generic driver

Highest flexibility

- Service-friendly design – low maintenance cost
- Maximized uptime – 17 maintenance days in 17 years
- Fast gas generator exchange
- Maintenance on-site or at local service workshop

Excellent service friendliness

- Low environmental footprint
- Fourth generation DLE combustion system
- No seasonal DLE system tuning required
- Lowest emissions on the market with single-digit NO_x

Environmentally friendly

Thank you!

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