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

### Heavy-duty gas turbines
- **50Hz**
  - SGT5-9000HL: 564 MW
  - SGT5-8000HL: 465 MW
  - SGT5-8000H: 450 MW
  - SGT5-4000F: 329 MW
  - SGT5-2000E: 187 MW

- **60Hz**
  - SGT6-9000HL: 386 MW
  - SGT6-8000H: 310 MW
  - SGT6-5000F: 250 MW
  - SGT6-2000E: 117 MW

### Industrial gas turbines
- **50Hz or 60Hz**
  - SGT-A65: 53 to 66/54 to 62 MW
  - SGT-800: 48 to 57 MW
  - SGT-A45: 39 to 44 MW
  - SGT-750: 40/41 MW
  - SGT-700: 33/34 MW
  - SGT-A30 and SGT-A35: 27 to 37/28 to 38 MW
  - SGT-600: 24/25 MW
  - SGT-400: 13 to 14/13 to 15 MW
  - SGT-300: 8/8 to 9 MW
  - SGT-100: 5/6 MW
  - SGT-A05: 4 to 7 MW
Mobile Gas Turbines serve a fast growing Power-Gen market – Driven by Customer needs for Fast Power

Annual sales worldwide

<table>
<thead>
<tr>
<th>Year</th>
<th>Mobile Gas Turbines (# units)</th>
<th>Annual sales worldwide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999 – 2009</td>
<td>0.4 GW</td>
<td>20</td>
</tr>
<tr>
<td>2010 – 2016</td>
<td>1.6 GW</td>
<td>59</td>
</tr>
</tbody>
</table>

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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Page 4 May 2018
Siemens introduces the SGT-A45 mobile unit

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

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

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

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

**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

Gas Turbine manufacturing
Montréal, Canada

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

Package manufacturing
Houston, USA
The SGT-A45 superior performance drives better economics –
More power – Less units – Less fuel

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

<table>
<thead>
<tr>
<th>MW&lt;sub&gt;e&lt;/sub&gt;</th>
<th>Reciprocating engine</th>
<th>Other mobile GT</th>
<th>Siemens SGT-A45</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 MW ISO-rating</td>
<td>34 MW ISO-rating</td>
<td>44 MW ISO-rating</td>
</tr>
<tr>
<td>200</td>
<td>20</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>150</td>
<td>16</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>100</td>
<td>12</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>50</td>
<td>8</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

150 MW power plant
Annual fuel savings<sup>1</sup>
US$ 1,000,000 gas fuel
4,500,000 liters Diesel – Due to higher efficiency

<sup>1</sup> 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

SGT-A45 Mobile Unit

44 MW<sub>e</sub>

Gas Turbine pedigree

- Rolls-Royce Trent 800
  - 28 m flight hours
- Siemens SGT-A65
  - (Industrial Trent 60)
  - 1.5 m service hours

Common technology platform
Extended portfolio

SGT-A35
(Industrial RB211-GT30)
38 MW

Rolls-Royce MT30 Marine
36 MW

SGT-A45
44 MW

SGT-A65
(Industrial Trent 60)
66 MW

LP booster removed

Free Power Turbine
Derived from Industrial/Aero/Marine Trent
SGT-A45 heritage – SGT-A65 (Industrial Trent 60) – Fleet experience in all regions

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

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

North America
- Canada 2
- USA 22

Middle East
- Israel 2
- Qatar 9
- Saudi Arabia 1
- UAE 7

Europe and Cis
- Belgium 4
- Czech Republic 1
- Denmark 2
- Germany 6
- Russia 8
- Slovakia 1
- Turkey 1
- Hungary 2
- UK 7

China
- China 1

Latin America
- Bolivia 1
- Chile 2
- Mexico 2
- Argentina 2
- Venezuela 14

Africa
- Nigeria 2

Asia-Pacific
- Australia 5
- Indonesia 1
- New Caledonia 2

Canada 2
USA 22
North America
Canada 2
USA 22

China
- China 1

Europe and Cis
- Belgium 4
- Czech Republic 1
- Denmark 2
- Germany 6
- Russia 8
- Slovakia 1
- Turkey 1
- Hungary 2
- UK 7

Middle East
- Israel 2
- Qatar 9
- Saudi Arabia 1
- UAE 7

Africa
- Nigeria 2

Asia-Pacific
- Australia 5
- Indonesia 1
- New Caledonia 2

115 SGT-A65 units sold
1.65 Million SGT-A65 operating hours

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There of 100 units for Industrial Power Generation
15 units in Oil and Gas applications

1.65 Million SGT-A65 operating hours

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1.65 Million SGT-A65 operating hours
SGT-A45 Performance Ratings – 60 Hz – Significantly more mobile power

60 Hz generation – Power and Efficiency

* High fuel efficiency minimizes life cycle cost
* Water injection (optional) allows constant output @ 44 MWₑ 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

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

175 MW
With 4 units

2 Weeks
Gas turbine installation

Tailored solution
Flexible balance of plant scope

75 m
(Gas fuel only)

Dual fuel and water options
Based on Customer requirements

128 m

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**

**Typical scheduled maintenance plan**

<table>
<thead>
<tr>
<th>Level A</th>
<th>Minor inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level B</td>
<td>Hot section refurbishment</td>
</tr>
<tr>
<td>Level C</td>
<td>Major overhaul</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Full overhaul of cold and hot section of engine</td>
</tr>
<tr>
<td>- A Service plus:</td>
</tr>
<tr>
<td>- Service Exchange or Lease Engine</td>
</tr>
<tr>
<td>- Refurbishment done at Siemens approved workshop</td>
</tr>
<tr>
<td>- Borescope inspection of Gas Turbine</td>
</tr>
<tr>
<td>- Replenish/replace consumables of package</td>
</tr>
<tr>
<td>- Sensor calibration</td>
</tr>
</tbody>
</table>

**Operation Maintenance**

- 25k hrs
- 50k hrs
- 75k hrs
- 100k hrs

**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

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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siemens.com
Industrial gas turbine
SGT-750
Value for customers
The Siemens gas turbines portfolio:
The right engine for every requirement

<table>
<thead>
<tr>
<th>Heavy-duty gas turbines</th>
<th>Industrial gas turbines</th>
<th>Aeroderivative gas turbines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>50 Hz</strong></td>
<td><strong>60 Hz</strong></td>
<td><strong>50Hz or 60Hz</strong></td>
</tr>
<tr>
<td>SGT5-9000HL</td>
<td>SGT5-8000HL</td>
<td>SGT-A65</td>
</tr>
<tr>
<td>567 MW</td>
<td>567 MW</td>
<td>117 MW</td>
</tr>
<tr>
<td>SGT5-8000HL</td>
<td>SGT5-8000H</td>
<td>SGT-800</td>
</tr>
<tr>
<td>481 MW</td>
<td>481 MW</td>
<td>66 to 72 / 58 MW</td>
</tr>
<tr>
<td>SGT5-4000F</td>
<td>SGT5-2000E</td>
<td>SGT-A45</td>
</tr>
<tr>
<td>329 MW</td>
<td>329 MW</td>
<td>48 to 57 MW</td>
</tr>
<tr>
<td>SGT6-9000HL</td>
<td>SGT6-9000H</td>
<td>SGT-750</td>
</tr>
<tr>
<td>388 MW</td>
<td>388 MW</td>
<td>41 to 44 MW</td>
</tr>
<tr>
<td>SGT6-8000H</td>
<td>SGT6-8000F</td>
<td>SGT-700</td>
</tr>
<tr>
<td>310 MW</td>
<td>310 MW</td>
<td>40 / 44 MW</td>
</tr>
<tr>
<td>SGT6-5000F</td>
<td>SGT6-5000F</td>
<td>SGT-700</td>
</tr>
<tr>
<td>250 MW</td>
<td>250 MW</td>
<td>33 / 34 MW</td>
</tr>
<tr>
<td>117 MW</td>
<td>117 MW</td>
<td>27 to 37 / 28 to 38 MW</td>
</tr>
<tr>
<td>SGT-A2000F</td>
<td>SGT-A2000F</td>
<td>SGT-600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 / 25 MW</td>
</tr>
<tr>
<td>SGT-A35</td>
<td>SGT-A35</td>
<td>SGT-400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13 to 14 / 13 to 15 MW</td>
</tr>
<tr>
<td>SGT-600</td>
<td>SGT-600</td>
<td>SGT-300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 / 8 to 9 MW</td>
</tr>
<tr>
<td>SGT-100</td>
<td>SGT-100</td>
<td>SGT-100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 / 6 MW</td>
</tr>
<tr>
<td>SGT-A05</td>
<td>SGT-A05</td>
<td>SGT-300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 to 7 MW</td>
</tr>
<tr>
<td>KG2</td>
<td>KG2</td>
<td>KG2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 MW</td>
</tr>
</tbody>
</table>
Siemens gas turbine installations

- 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

| 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 NOₓ over a wide load range

- **Highest efficiency**
  → close to 42%

- **Guaranteed power and efficiency over a long time of period**
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

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

Infra Red Cameras
- Mapped with infrared (IR) cameras during engine delivery test and during regular scheduled inspections
- Gives online blade temperature measurements

Best-in-class performance
Maximized uptime
Fuel and operational flexibility
Pitch & Roll capability
Flexibility, Performance, Serviceability
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 NOx 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/nm³ proven

<table>
<thead>
<tr>
<th>Gas Fuel Constituents</th>
<th>Max mole %</th>
<th>Max mole %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane, CH₄</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Ethane, C₂H₆</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Propane, C₃H₈</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Butanes and heavier alkanes, C₄+</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Hydrogen and carbon monoxide, H₂ + CO</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Inerts, N₂/CO₂</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>Hydrogen sulfide H₂S</td>
<td>50/40</td>
<td>0</td>
</tr>
</tbody>
</table>
Market-leading emissions over a wide load range

<table>
<thead>
<tr>
<th>Gas fuel type</th>
<th>Natural gas</th>
<th>Diesel No.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 – 100% load</td>
<td>≤9 ppmv</td>
<td>≤25 ppmv*</td>
</tr>
<tr>
<td>NO\textsubscript{X} @ 15% O\textsubscript{2}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 – 100% load</td>
<td>≤25 ppmv</td>
<td>≤25 ppmv</td>
</tr>
<tr>
<td>CO @ 15% O\textsubscript{2}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*water injection

- Single digit NO\textsubscript{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

Maintenance plan schedule

<table>
<thead>
<tr>
<th>Equivalent operating hours (EOHs)</th>
<th>34,000</th>
<th>68,000</th>
<th>102,000</th>
<th>136,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation Maintenance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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
Reference: Kaltex Altamira

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

- 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

Emergency parts
- Emergency gas generators
- 24-hour telephone support
Innovative and well-matched products to your requirements

- 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\textsubscript{x}

- Environmentally friendly
Thank you!

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