Power to Drive Fracing 2.0: Modular Electrification Solutions that Easily Scale

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Director, Global Unconventional Oil and Gas Solution Development
Siemens Energy, Inc
Electrification and Digitalization
Proven in multiple industries

Coastal transportation & Marine

Zero emission ferry "MF Ampere"
- Capacity: 120
- Distance: 6 km
- Fuel Cost savings: 60%

Operation since March 2015

Mining

1. Remote diagnosis facilitates predictive maintenance
2. Shift from corrective to preventive measures
3. Increased availability and avoidance of unplanned downtimes

99.9% availability
High-speed train service Barcelona – Madrid
Full reimbursement of ticket prices for passengers when a train is >15 minutes late
Only ONE of 2,300 trips is really late

Offshore Oil & Gas

1. Wind Turbine Integration
2. ESS Integration
   - Batteries
   - Supercaps
   - Flywheels
   - Fuelcells
   - Photovoltaic
3. Gas Turbine Integration
4. Diesel / Gas Engine Integration
5. Power from Shore Integration
6. DC Grids with Battery ESS
7. Subsea Power & Drives Integration

10 years of providing operations intelligence for upstream
Unified central data hub
All multi-discipline design data accessible in one data base
Siemens technical experts
Support analysis of critical rotating equipment
Predictive maintenance – Schedule maintenance to optimize plant availability

Mobility

Remote monitoring facilitates expert center support
Reduced cost for commissioning and operation
Increased availability and avoidance of unplanned downtimes

High-speed train service
Barcelona – Madrid
Full reimbursement of ticket prices for passengers when a train is >15 minutes late
Only ONE of 2,300 trips is really late
Electrification and Digitalization of pressure pumping is underway
Interest is growing

First and second generation designs deployed and in commercial operation
- More power density
- Fewer people
- Lower operating cost
- Better environmental performance

Fleet growth accelerating in early adoption phase
- Pace uncertain

Innovation and creativity evident
- New systems and approaches
- Improved efficiencies

INCUMBENT – Frac 1.0

INNOVATORS – Frac 2.0

- Cloud & edge analytics
- Automation
- Electrical power
- Mechanical drive
- New systems and approaches
- Improved efficiencies
Fast Mobile Power

- Rig up in **under 2 hours**
- Full power **within 1 minute**
- Single trailer design
- **Minimal** maintenance requirements
- DOT permit weight
- **Quiet**
- **Fuel savings** from burning wellhead gas
Variable Speed Drive and Electric Motor

• Fast and precise flow control
• Heavy duty, high torque traction motors
• Decades of proven ruggedness and reliability in mining operations
• High reliability and uptime
SGT-A05 KB7HE
Siemens new and improved SGT-A05 KB7HE Aero-derivative gas turbine

Simple cycle power generation: 5.8 MW(e)
SGT-A05 Mobile Power key dimensions and Service information

**OA Height:** 13.79 ft

**OA Length:** 53.0 ft

**OA Width** (over door latches): 8.57 ft

**Weight:** approx. 110,000 lbs

**5 axles:** with 2 x steerable and 1x lift axle

**Mobility implications**
- Permit Load
- No flag car
- Bridge ready
- Designed for mobility on well pad site and off-road shock and vibration

**Service interval**

**GT Overhaul:**
- 30 000 hrs light overhaul
- 60 000 hrs heavy overhaul

**Aero engine fast core swap-out**
SGT – A05 Mobile Power Configuration

Complex design with three core areas:

- Package Design for mobile applications
- Siemens SGT-A05 Gas Turbine + Gearbox and Generator
- Siemens Gas Insulated MV Switchgear NXPLUS C
SGT-A05 Mobile Power
Standard configuration

On site activities
- Level the unit
- Unlock gearbox
- Fire suppression activation
- Connect
  - gas manifold
  - black start generator
  - power cables
- (Pre-warm lube oil if required)
- Start to full power in 1 minute
- Down to 2 hours rig-in with practiced team.

Noise
- Far Field
  - 59 dBA at 350’
  - 69 dBC at 350’
- Near field noise limit averaging 85dBA Near Field 3ft at ground level
- Ultra quiet option available
Mobile Gas Turbine Generator units

- Reduce Noise levels
- Reduce maintenance costs
- Eliminate unplanned asset downtime
- Reduce fuel costs
- Reduce emissions

Scalable mobile units

<table>
<thead>
<tr>
<th>Power</th>
<th>Generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.9 MW</td>
<td>SGT A05</td>
</tr>
<tr>
<td>7.9 MW</td>
<td>SGT 300</td>
</tr>
<tr>
<td>45 MW</td>
<td>SGT A45</td>
</tr>
</tbody>
</table>

Fuel Flexible
Emmissions compliant
Fast rig up and down
Hot start
Low community impact
Compact

- Proven and deployed
- In Development
- Proven and deployed
SGT 300 Mobile Power Overview – in development

Compact
Single trailer solution

Fast rig up and down
• 4 hours rig-in.

High Availability
• No ‘hot lock-out’. Rugged and proven work-horse

Low impact on communities
• Quiet, Near field 90 dBA or better

Meets stringent emissions targets
• Dry Low Emissions (DLE) combustion reduction system
• High levels of fuel flexibility. Capable to burn wide range of well head gases

Key Metric
• Turbine 7.9 MWe @ ISO conditions
SGT-300 Dry Low Emissions Combustion

- 7.9 MW (e) at ISO conditions
- 15 ppm NOx @ 15% O2 Dry
- Six reverse flow tubular chambers
- Low Emissions Burner
- High energy igniter in each combustor
- Intelligent combustion controls
- Automatic changeover from primary to secondary fuel
- Wide range of fuel flexibility
- Radial swirl air injection for fuel optimization

SGT-300 DLE – Continuous Research & Development supported by millions of operating hours & rig testing to enhance fuel flexibility and reduce emissions
**SGT-300 Fuel Flexibility**

- Experience with traditional and alternative fuels, including landfill and associated gas.
- Detailed specifications driving the fuel requirements to meet performance criteria.
- Pre-treatment of wellhead gas mainly includes:
  - Heating to a minimum of 212 degree F
  - Coalescing filtration to eliminate moisture

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**Actual operating data of a SGT-300 DLE with a tri-fuel system (natural gas, liquid fuel, and landfill gas)**

**SGT-300 DLE – Wide range of fuel flexibility and low emissions compliance proven globally**
Digital Solutions and Drive Train Analytics

- Life cycle history of transportation conditions (Shock & vibration) with monitoring and alarms in transit
- Pre-mobilization mapping of road conditions for driver awareness and route planning
- Real time situation awareness & updates to driver
- Site level comparison for key equipment of factory operating signature to first start on site with alarms
- Ongoing monitoring and analysis of performance characteristics on site and in cloud
Opportunities

**Lower Capex and increase reliability**
- High density pumps – more HHP for the same footprint
- High density generators electric motors and integrated drives
- New distribution architectures

**Improve environmental performance**

**Energy efficiency & low carbon intensity**
- Hybrid systems for peak load energy mgmt.
- Power management
- Gas turbine exhaust heat recovery
- Grid connections to renewable energy sources

**Emissions**
- Dry low emissions combustion systems

**Reduce Operational costs**
- Digital strategies for fleet management – increasing availability and reliability of deployed systems
- More sophisticated process controls and learning systems for optimization
- Remote Monitoring and Operations with increased automation
- Increased use of flare and wellhead gas streams
Sustainability measures addressed
Where is value being created?

Environmental Metrics
- Energy Efficiency
- Pollution Emissions to air
- Traffic pressure
- Noise levels

Economic Metrics
- Capex per HHP utilized
- Opex: maintenance costs
- Process optimization through data analytics and better control
- Fuel costs
- Improved reliability Redundancy and NPT
- Capital efficiency Asset availability
- Site footprint cost and impact
- Manpower requirements

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