

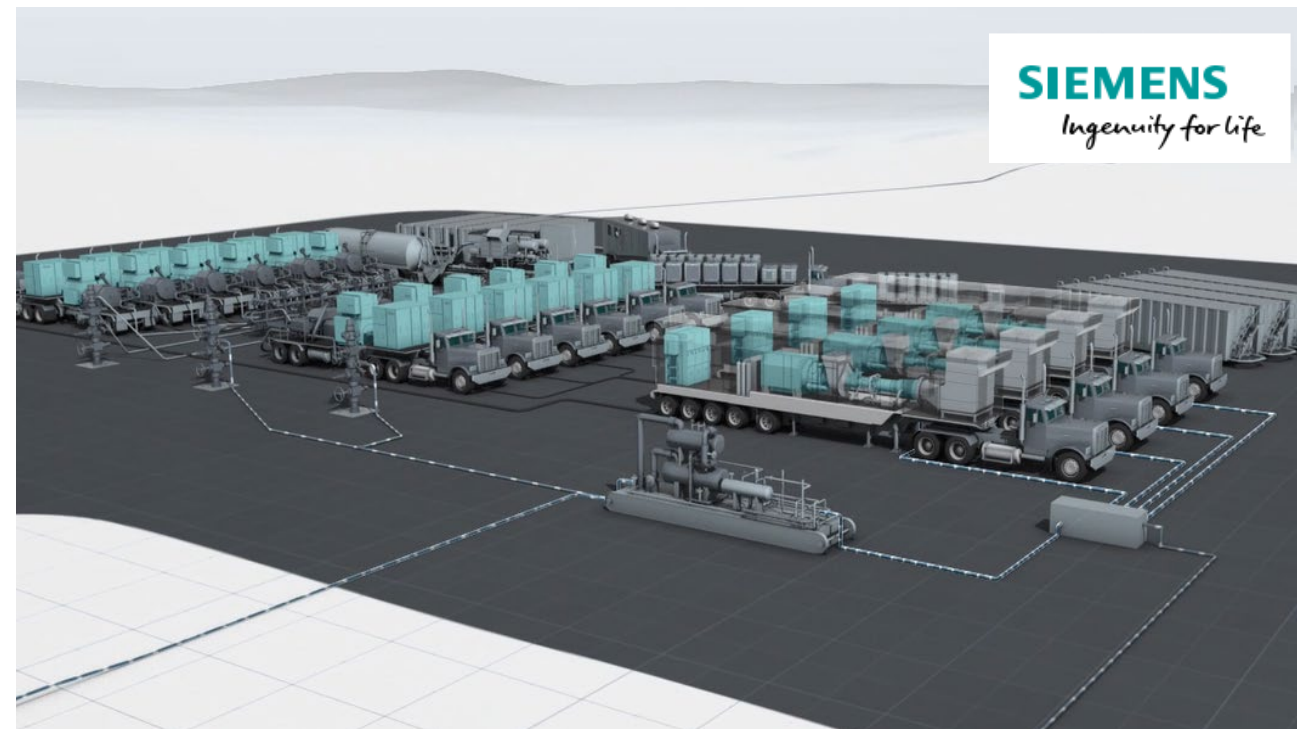


# GTEN 2019 Symposium

October 21st - 23rd, 2019

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

Dalia El Tawy  
Director, Global Unconventional Oil and  
Gas Solution Development  
Siemens Energy, Inc



# Electrification and Digitalization Proven in multiple industries

**SIEMENS**  
*Ingenuity for life*

## Coastal transportation & Marine

### Zero emission ferry "MF Ampere"

Capacity Distance Fuel Cost savings

120 6 km  
360 (in 20 min)

**60%**

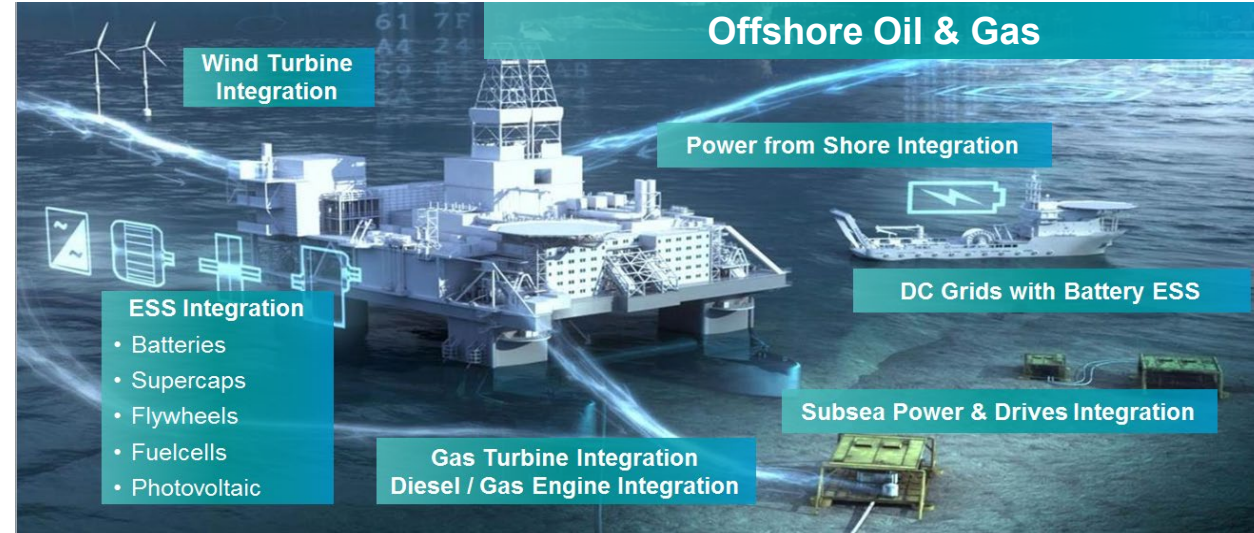
Operation since March 2015



## Mining



## Offshore Oil & Gas



## Mobility



**Remote diagnosis**  
facilitates predictive maintenance



**Shift**  
from corrective to preventive measures



**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



**Remote monitoring facilitates** expert center support



**Reduced cost** for commissioning and operation



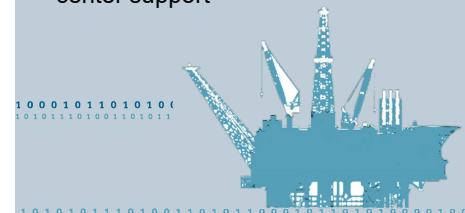
**Increased availability** and avoidance of unplanned downtimes

**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



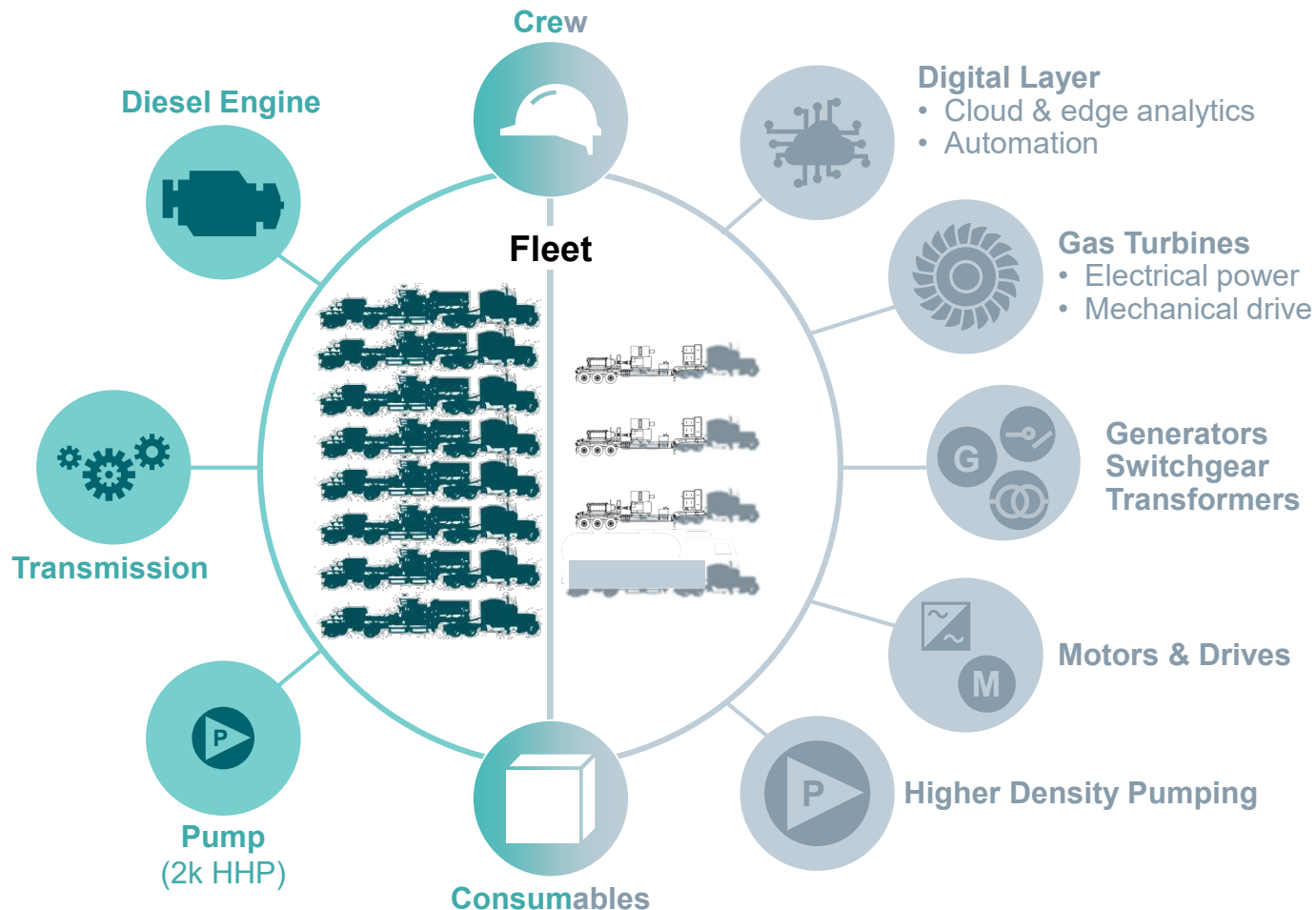


# Electrification and Digitalization of pressure pumping is underway

## Interest is growing



INCUMBENT – Frac 1.0 → INNOVATORS – Frac 2.0



### 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

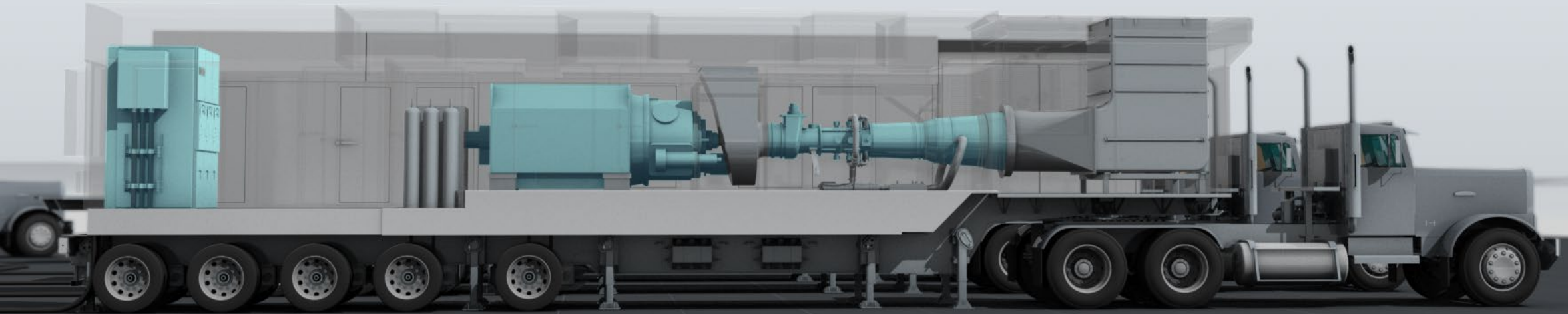
- Pace uncertain

### Innovation and creativity evident

- New systems and approaches
- Improved efficiencies

## 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



A row of Siemens electric motors and drive cabinets in an industrial setting. The motors are teal-colored and mounted on a metal frame. The drive cabinets are also teal and have multiple doors. The background shows a factory floor with various equipment and structures.

# Motor

# Drive

## 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

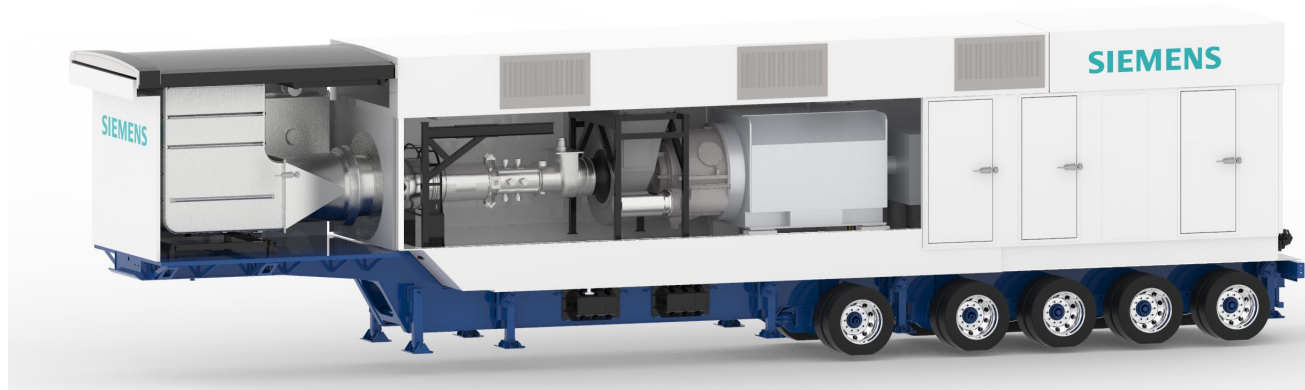
- Permit Load
- No flag car
- Bridge ready
- Designed for mobility on well pad site and off-road shock and vibration

## Service interval

### **GT Overhaul:**

- 30 000 hrs light overhaul
- 60 000 hrs heavy overhaul

### **Aero engine fast core swap-out**

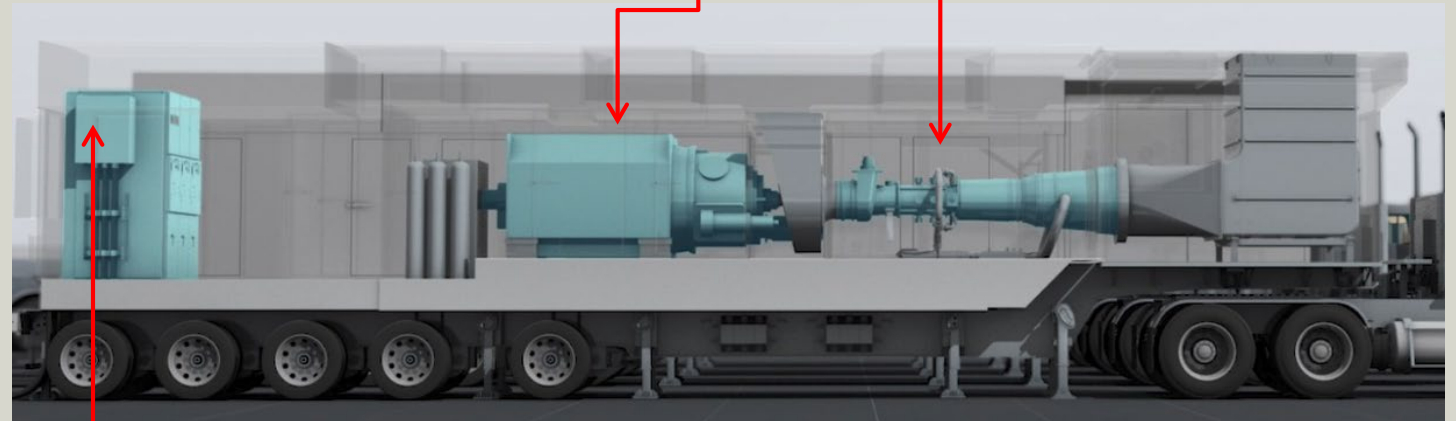


# SGT –A05 Mobile Power Configuration



## 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

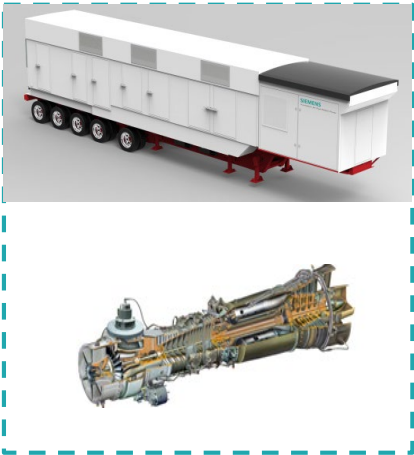
## Scalable mobile units

5.9 MW

7.9 MW

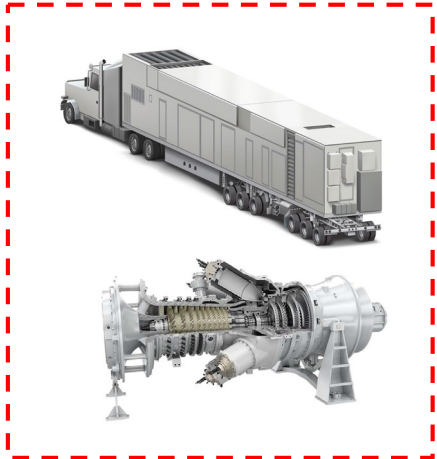
45 MW

SGT A05



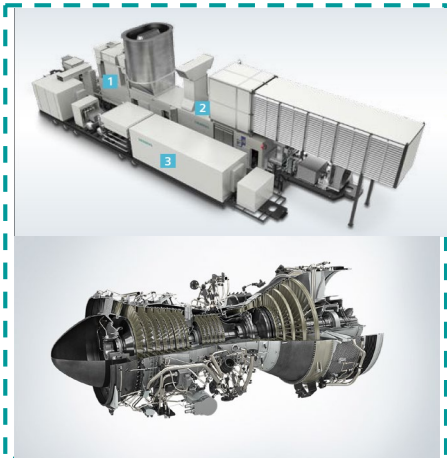
Proven and deployed

SGT 300



In Development

SGT A45



Proven and deployed

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

# 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

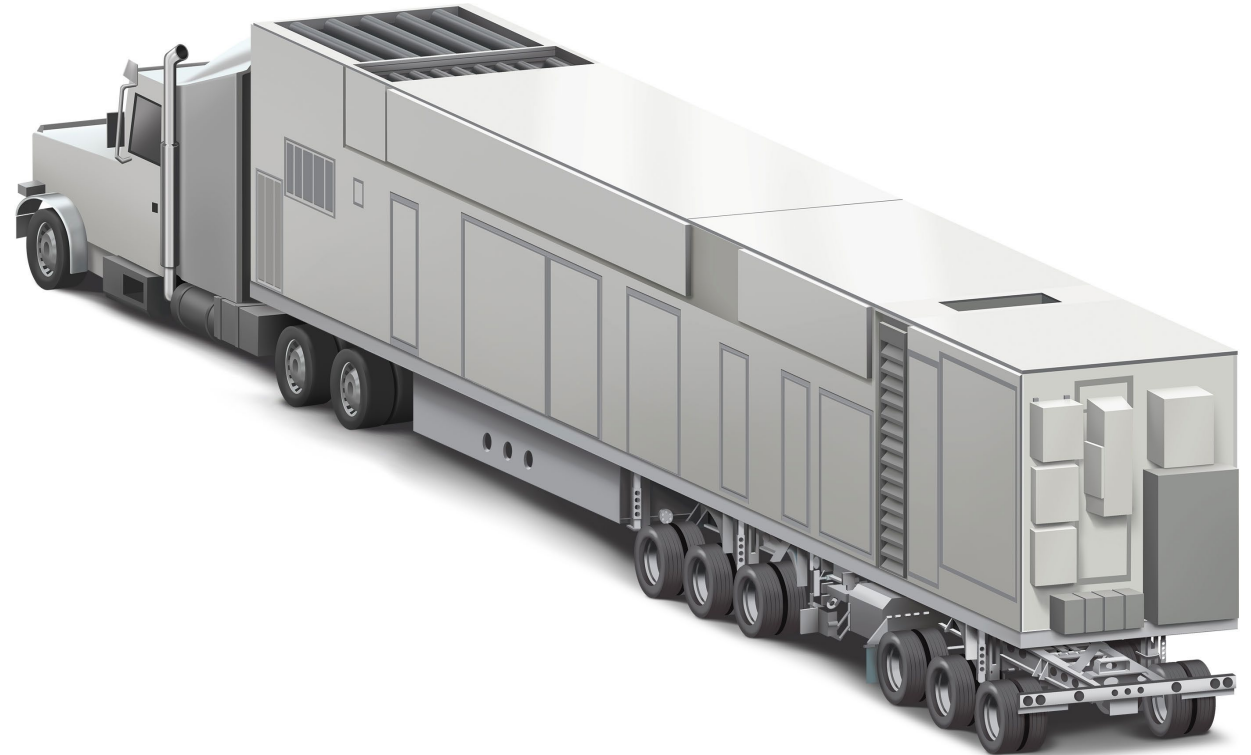
- Quiet, Near field 90 dBA or better

## 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

**SIEMENS**  
*Ingenuity for life*

## Compressor

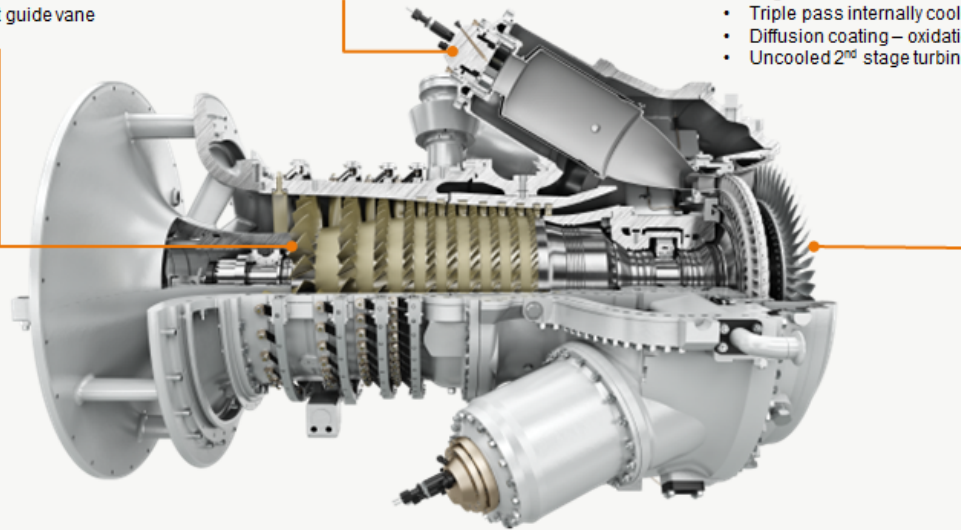
- 10-stage transonic compressor
- Pressure ratio (ISO): 13.7:1
- Airflow (ISO): 65.6 lb/s (29.8 kg/s)
- Variable inlet guide vane and stators

## Combustion system

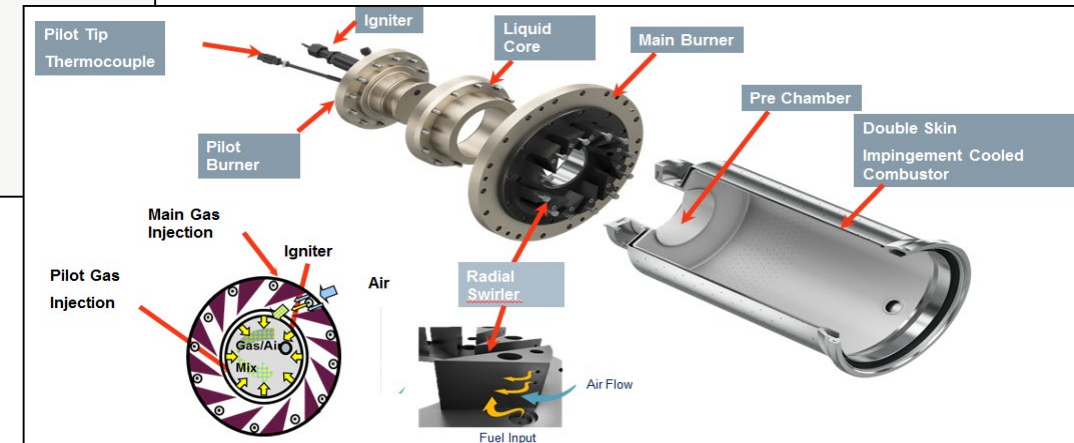
- Six reverse flow tubular chambers
- Low Emissions Burner
- High energy igniter in each combustor
- Intelligent combustion controls

## Gas Generator Turbine

- Stage 1 & 2 blade profiles as per SGT-400
- 2-stage overhung compressor turbine
- Rotor mounted on 2 bearings 2 stage overhung transonic turbine
- Segmented turbine stators
- Triple pass internally cooled 1<sup>st</sup> stage rotor blade
- Diffusion coating – oxidation/corrosion protection
- Uncooled 2<sup>nd</sup> stage turbine

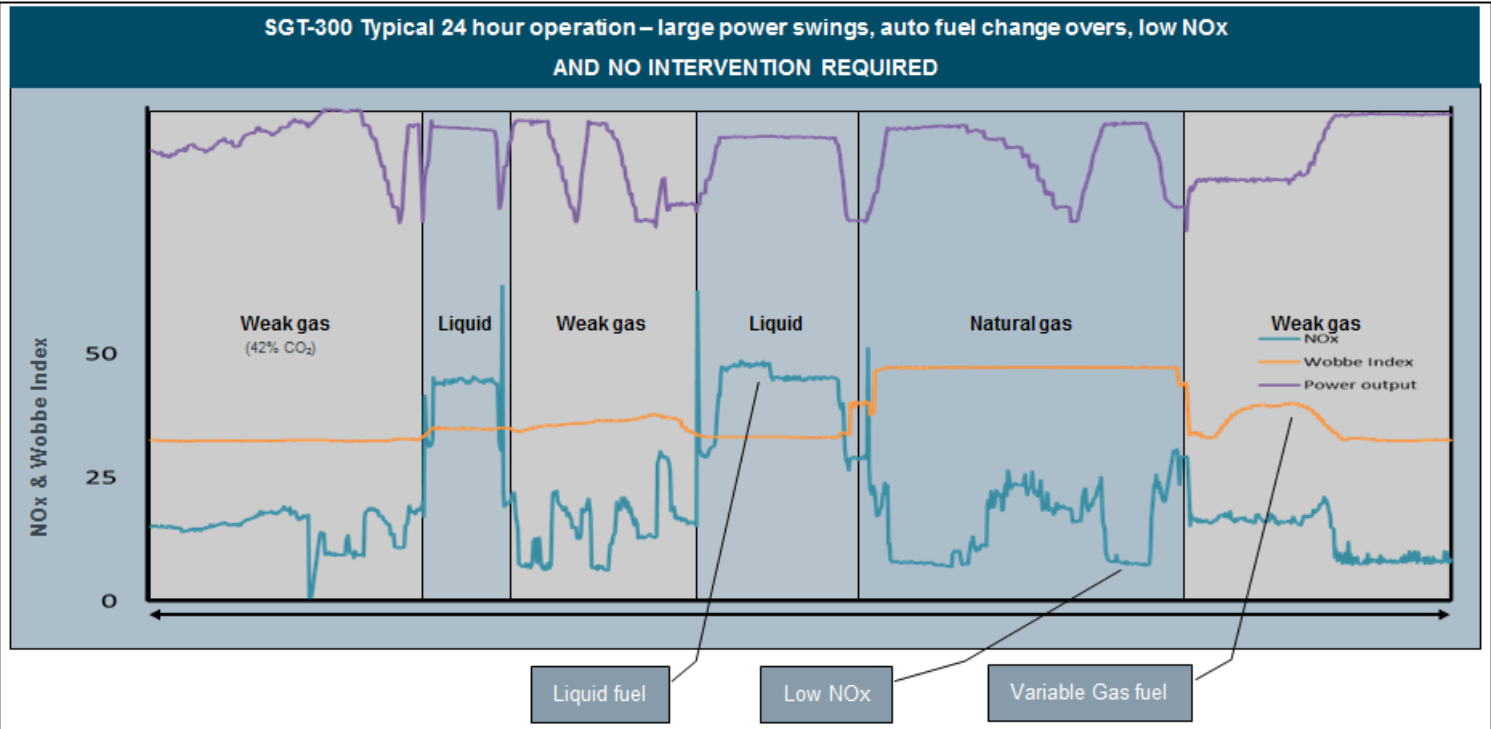


- 7.9 MW (e) at ISO conditions
- 15 ppm NO<sub>x</sub> @ 15% O<sub>2</sub> Dry
- Six reverse flow tubular chambers
- Low Emissions Burner
- High energy igniter in each combustor
- Intelligent combustion controls
- Automatic changeover from primary to secondary fuel
- Wide range of fuel flexibility
- Radial swirl air injection for fuel optimization



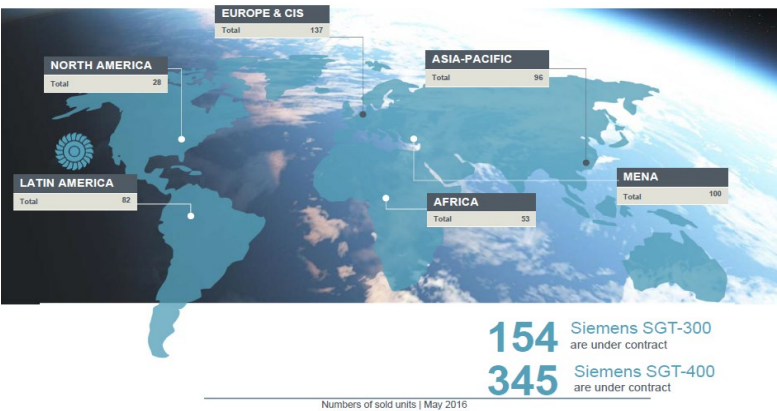
SGT-300 DLE – Continuous Research & Development supported by millions of operating hours & rig testing to enhance fuel flexibility and reduce emissions

# SGT-300 Fuel Flexibility



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

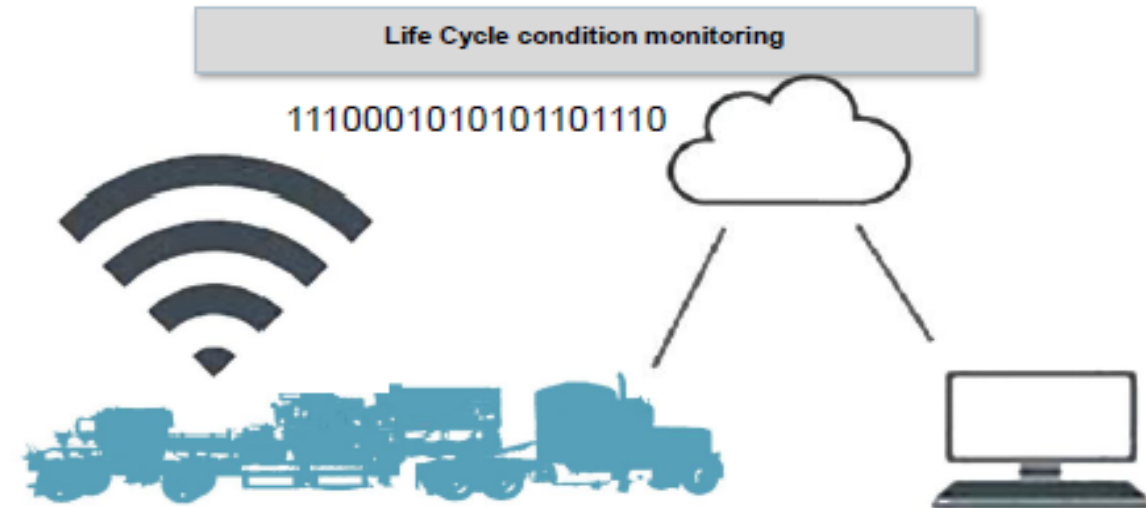
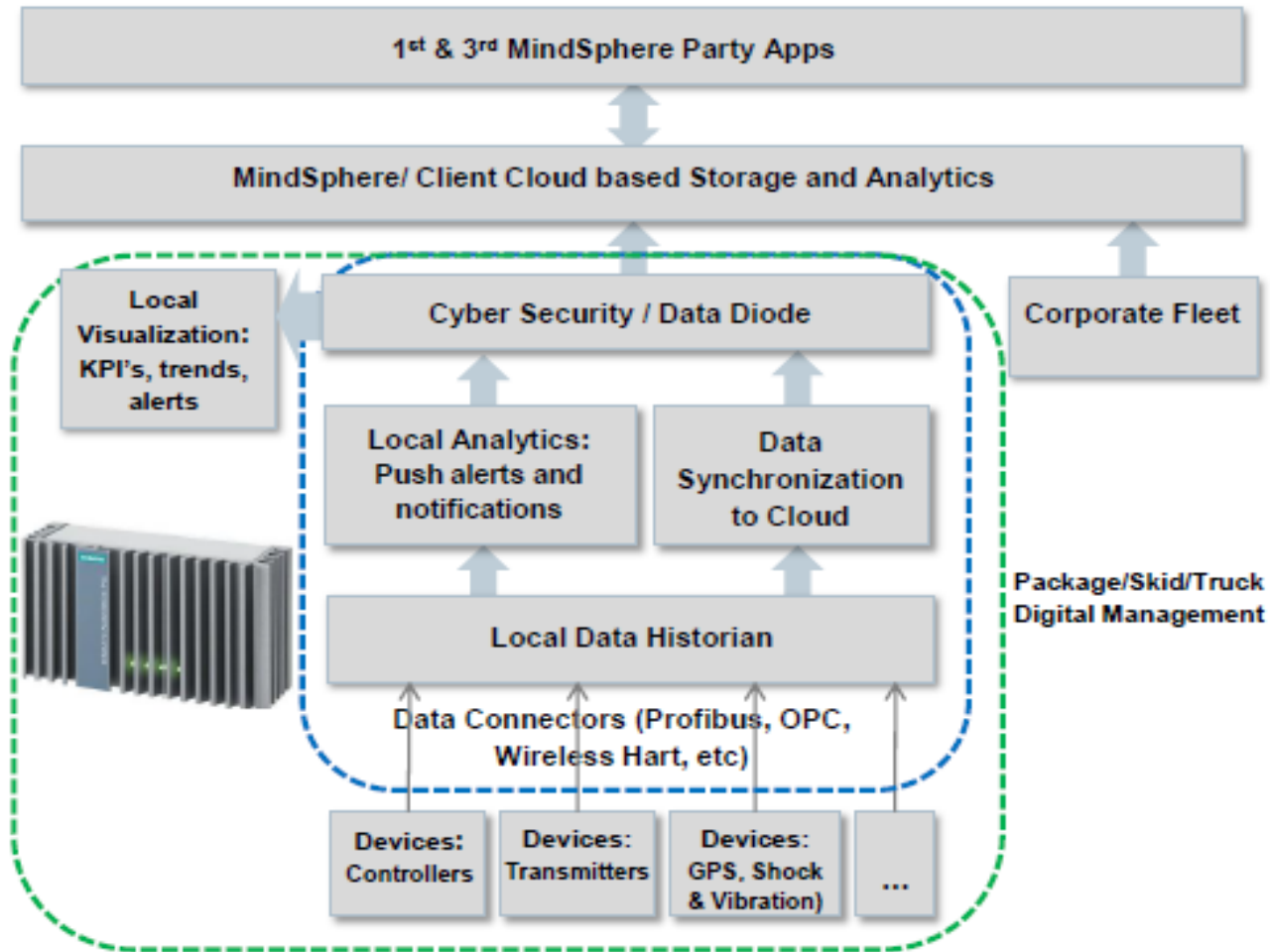
- Experience with traditional and alternative fuels, including landfill and associated gas.
- Detailed specifications driving the fuel requirements to meet performance criteria.
- Pre-treatment of wellhead gas mainly includes:
  - Heating to a minimum of 212 degree F
  - Coalescing filtration to eliminate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



SGT-300 – more than 5.3 million operating hours  
SGT-400 – more than 2.5 million operating hours

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



## 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



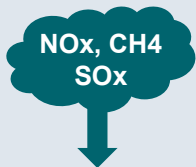
# Sustainability measures addressed

## 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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