Solar® Turbines
A Caterpillar Company

POWERING THE GLOBAL ENERGY DEMAND

Turbomachinery Systems

For Oil and Gas Applications

Compressor Sets

Mechanical Drive Sets

Generator Sets

Centrifugal Gas Compressors

Performance to Power the Oil and Gas Industry

Since Solar Turbines entered the industrial gas turbine business in 1960, the fleet of Solar gas turbines installed worldwide has grown to more than 13,900 units and those turbines have logged well over 1.7 billion hours in 98 countries.

In 1980, Solar introduced its first electric motor drive package. There are now more than 110 electric motor drive units installed worldwide.

Customers are operating Solar turbomachinery in the toughest, most challenging environments, including remote arctic, desert, tropical and offshore areas. Our rugged, robust, highly reliable gas turbines and electric motor drives offer competitive efficiencies in their power class with the most durable products available.

Solar offers factory packaged gas turbine or electric motor driven compressor sets, mechanical-drive packages and generator sets in the 1-to-22 MW output range.

Single-Source Advantages

Solar Turbines Incorporated designs and manufactures its gas turbines, electric motor drives (EMDs) and turbomachinery packages to ensure maximum systems compatibility and integration, plus high performance, reliability, availability, efficiency and long life in the most demanding applications. As the customer's single source, Solar can also provide:

- Commissioning
- Technical training
- Field service
- Certified parts
- Repairs, overhauls, upgrades
- Complete project operation and maintenance
- Engineering, procurement, and construction (EPC)
- Contract power and leasing
- Financing programs

Efficiency

Solar® turbines are designed for efficient, simple-cycle operation, and they can provide overall system thermal efficiencies from 70-80% when both their shaft power and exhaust heat energy are harnessed.

Transportability

Solar turbine packages are lightweight and compact for easy transportation and installation.

A gas turbine package's high power density, ease of transport by standard conveyances, and easy installation can pay off in lower installed cost per horsepower.

Availability

Durability and reliability are only part of the *Solar* turbine availability story. The units have many built-in features for temperature and vibration instrumentation, rapid component removal, and easy inspection to speed maintenance and maximize availability.

Customized Packages

Solar builds complete turbomachinery packages that are ready to go to work... no matter where the job may be. From pre-engineered designs to highly specialized requirements, Solar can provide the solution for your needs. Solar designs and manufactures its gas turbines and turbomachinery packages under quality management systems, maintaining ISO 9001 certification since 1992.

Pipeline Compression
Titan 130
Mississippi, USA

Product Choices

Gas Transmission
Titan 250
Tennessee, USA

Compressor sets, which utilize Solar's family of centrifugal gas compressors, are designed for applications in the oil and gas industry such as:

- Natural gas gathering
- Transmission
- Storage/withdrawal
- Gas lift
- Export sales gas

Mechanical drive packages are ideally suited for driving:

- Centrifugal compressors manufactured by other suppliers for air, process and refrigeration applications.
- Reciprocating compressors

The versatile mechanical drives also power pumps for:

- Transporting crude oil
- Transporting liquid products
- Waterflood

Generator sets, rated from 1-to-21.7 MWe, are used worldwide for a variety of applications including:

- Offshore platform and FPS power generation
- Gas production and process facility power generation
- Cogeneration

Whether designed in constant-speed single-shaft, or variable-speed two-shaft configuration, Solar's line of industrial gas turbines is designed with:

- Axial-flow air compressors
- Single annular combustors
- Axial-flow gas generator turbines and power turbines

The two-shaft configurations are designed especially for mechanical drive applications. Their power turbine is mechanically independent of the gas generator to provide optimal control over a wide range of speeds and loads.

The single-shaft configurations are designed specifically for power generation and use an epicyclic speed-reduction gearbox to couple the gas turbine to the generator.

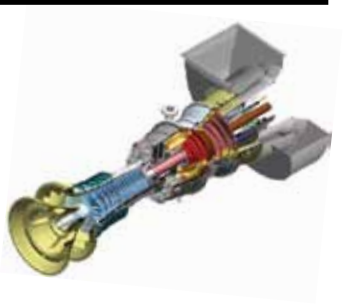
The *Mars* and *Titan* 250 gas turbines are available only in a two-shaft configuration for all applications.

Power Generation
Mars 100
Offshore Nigeria

Performance Coverage

Titan™ 250 Mechanical Drive Performance

ISO Continuous Duty Output	23 370 kW 30,000 hp
Heat Rate	9000 kJ/kW-hr 6360 Btu/hp-hr
Exhaust Flow	245 660 kg/hr 541,590 lb/hr
Exhaust	465 °C 865 °F



Titan 250 Generator Set Performance

ISO Continuous Duty Output	21 745 kWe
Heat Rate	9260 kJ/kWe-hr 8775 Btu/kWe-hr
Exhaust Flow	245 660 kg/hr 541,590 lb/hr
Exhaust	465 °C 865 °F

Titan 130 Mechanical Drive Performance

ISO Continuous Duty Output	15 290 kW 20,500 hp
Heat Rate	9940 kJ/kW-hr 7025 Btu/hp-hr
Exhaust Flow	180 050 kg/hr 396,940 lb/hr
Exhaust	505 °C 940 °F

Titan 130 Generator Set Performance

ISO Continuous Duty Output	15 000 kWe
Heat Rate	10 230 kJ/kWe-hr 9695 Btu/kWe-hr
Exhaust Flow	179 250 kg/hr 395,180 lb/hr
Exhaust	495 °C 925 °F

Mars® 100 Mechanical Drive Performance

ISO Continuous Duty Output	11 860 kW 15,900 hp
Heat Rate	10 465 kJ/kW-hr 7395 Btu/hp-hr
Exhaust Flow	153 245 kg/hr 337,850 lb/hr
Exhaust	485 °C 905 °F

Mars 100 Generator Set Performance

ISO Continuous Duty Output	11 350 kWe
Heat Rate	10 935 kJ/kWe-hr 10,365 Btu/kWe-hr
Exhaust Flow	153 245 kg/hr 337,850 lb/hr
Exhaust	485 °C 905 °F

Mars 90 Mechanical Drive Performance

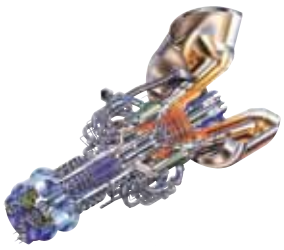
ISO Continuous Duty Output	9690 kW 13,220 hp
Heat Rate	10 830 kJ/kW-hr 7655 Btu/hp-hr
Exhaust Flow	144 585 kg/hr 318,755 lb/hr
Exhaust	465 °C 870 °F

Mars 90 Generator Set Performance

ISO Continuous Duty Output	9450 kWe
Heat Rate	11 300 kJ/kWe-hr 10,710 Btu/kWe-hr
Exhaust Flow	144 590 kg/hr 318,760 lb/hr
Exhaust	465 °C 870 °F

Taurus™ 70 Mechanical Drive Performance

ISO Continuous Duty Output	8140 kW 10,915 hp
Heat Rate	10 195 kJ/kW-hr 7205 Btu/hp-hr
Exhaust Flow	97 770 kg/hr 215,545 lb/hr
Exhaust	510 °C 945 °F



Taurus 70 Generator Set Performance

ISO Continuous Duty Output	7965 kWe
Heat Rate	10 505 kJ/kWe-hr 9955 Btu/kWe-hr
Exhaust Flow	96 775 kg/hr 213,350 lb/hr
Exhaust	510 °C 945 °F

Taurus 60 Mechanical Drive Performance

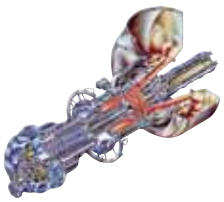
ISO Continuous Duty Output	5740 kW 7700 hp
Heat Rate	11 265 kJ/kW-hr 7965 Btu/hp-hr
Exhaust Flow	77 880 kg/hr 171,690 lb/hr
Exhaust	510 °C 950 °F

Taurus 60 Generator Set Performance

ISO Continuous Duty Output	5670 kWe
Heat Rate	11 430 kJ/kWe-hr 10,830 Btu/kWe-hr
Exhaust Flow	78 385 kg/hr 172,810 lb/hr
Exhaust	510 °C 950 °F

Centaur® 50 Mechanical Drive Performance

ISO Continuous Duty Output	4570 kW 6130 hp
Heat Rate	12 030 kJ/kW-hr 8500 Btu/hp-hr
Exhaust Flow	67 760 kg/hr 149,380 lb/hr
Exhaust	515 °C 960 °F



Centaur 50 Generator Set Performance

ISO Continuous Duty Output	4600 kWe
Heat Rate	12 270 kJ/kWe-hr 11,630 Btu/kWe-hr
Exhaust Flow	68 680 kg/hr 151,410 lb/hr
Exhaust	510 °C 950 °F

Centaur 40 Mechanical Drive Performance

ISO Continuous Duty Output	3500 kW 4700 hp
Heat Rate	12 905 kJ/kW-hr 9125 Btu/hp-hr
Exhaust Flow	68 185 kg/hr 150,320 lb/hr
Exhaust	445 °C 835 °F

Centaur 40 Generator Set Performance

ISO Continuous Duty Output	3515 kWe
Heat Rate	12 910 kJ/kWe-hr 12,240 Btu/kWe-hr
Exhaust Flow	68 365 kg/hr 150,715 lb/hr
Exhaust	445 °C 835 °F

Saturn® 20 Mechanical Drive Performance

ISO Continuous Duty Output	1185 kW 1590 hp
Heat Rate	14 670 kJ/kW-hr 10,370 Btu/hp-hr
Exhaust Flow	23 410 kg/hr 51,615 lb/hr
Exhaust	520 °C 970 °F

Saturn 20 Generator Set Performance

ISO Continuous Duty Output	1210 kWe
Heat Rate	14 795 kJ/kWe-hr 14,025 Btu/kWe-hr
Exhaust Flow	23 540 kg/hr 51,890 lb/hr
Exhaust	505 °C 940 °F

The information shown is for mechanical-drive packages and generator sets at full load under ISO conditions: 15°C (59°F), sea level, natural gas fuel, 60% relative humidity, zero inlet and exhaust losses. Power and efficiency ratings are nominal and generator set power is at the generator terminals.

Performance in Product Development

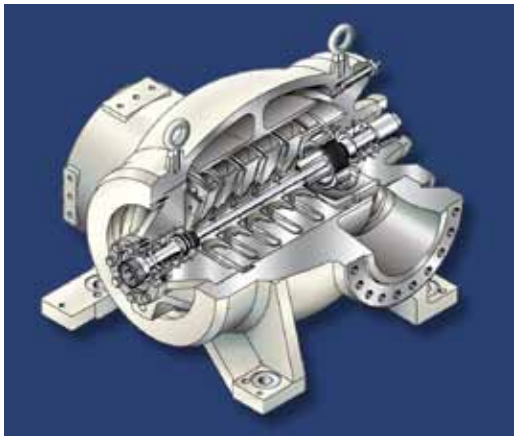
Solar gas turbines are a sustainable power source. They produce low exhaust emissions levels that meet virtually all emissions standards around the world. Solar offers gas turbine engines with pollution-prevention SoLoNOx™ dry lean pre-mixed combustion technology. This advanced combustion system offers the most cost-effective and environmentally friendly approach to significantly lower emissions since it does not consume water or require complex and costly add-on emissions control devices to attain low NOx and CO emissions levels. More than 2300 gas turbines with SoLoNOx technology have been installed worldwide and are designed to deliver the same ruggedness, reliability and operating flexibility for which Solar gas turbines are known. For areas requiring zero on-site emissions, Solar offers EMDs.

Pipeline Compression
Mars 90
Idaho, USA

SoLoNOx Technology

Centrifugal Natural Gas Compressors

Solar manufactures several API 617 compliant centrifugal natural gas compressor families, which incorporate many American Petroleum Institute (API) required features. Our fleet of more than 5000 installed compressors have a proven record of outstanding ruggedness, reliability and operational flexibility. They have pre-engineered, standardized components for maximum interchangeability and enhanced availability. Rapid field restaging is made possible because of their modular designs. *Solar* gas compressors have from 1 to 10 stages to handle flows from 4.25 to 1274 m^3/min (150 to 45,000 ft^3/min) and discharge pressures to 25 855 kPa (3750 psi).



Pipeline Compressors		Production Compressors	
	Number of Stages		Number of Stages
C40	1-2	C16	1-10
C45	1-3	C33	1-9
C65	1-2	C40	1-6
C85	1-2	C41	1-10
		C50	1-5
		C51	1-10
		C61	1-10

Customer Choices

Solar has designed, installed and supported packages worldwide. Additionally, we have extensive experience meeting code requirements such as API, ATEX, CENELEC, CSA and NEC. Typical package options include:

Start Systems

- AC direct-drive - VFD
- Pneumatic (mechanical drive/compressor sets)

Fuel Systems

- Natural gas
- Associated gas
- Distillates
- Natural gas liquids (NGL)
- Liquefied petroleum gases (LPG)
- Hydrogen blends
- Medium-Btu gases (such as coalbed methane, landfill, etc.)
- Dual- and tri-fuel systems

Lube Oil Systems

Oil system pump supply

- Engine-driven
- AC-motor driven

Integral lube oil tank reservoir

- Carbon steel
- Stainless steel

Lube oil cooling exchanger

- Water-to-oil
- Air-to-oil
- Low noise

Lube oil filters

- Dual with transfer valve

Complete Station Control Systems

Control and Monitoring Systems

- *Turbotronic*® microprocessor-based
- Onskid control
- Remote console option

Monitoring

- Remote
- Vibration
- Temperature
- Trending
- History

Displays

- Remote console
- Onskid digital displays

Skid Mounting Systems

- Multiple-point
- Three-point for offshore duty
- Floating platform capability

Mechanical Drives/Compressor Sets

Controls

- Process
- Surge control
- Sequencing of multiple units

Generator Sets

Generators

- 50 Hz standard voltages
- 60 Hz standard voltages

Controls

- Kilowatt control
- Auto start and synchronizing

Fast Delivery

World-class manufacturing facilities, processes and skilled personnel enable Solar to provide the shortest possible lead times for fully engineered packages tested to fulfill specific customer requirements.

Control Console

Package Assembly

Rotor Assembly

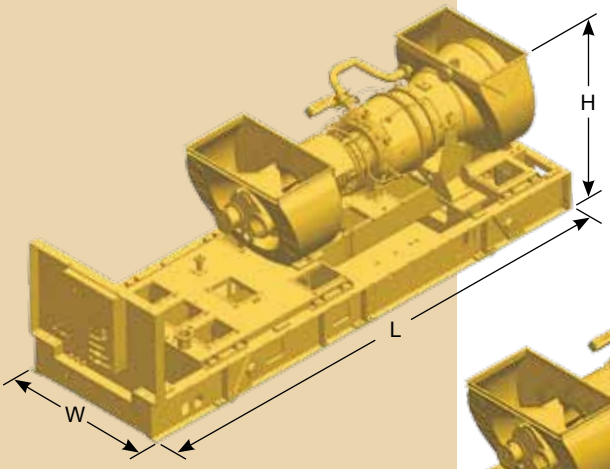
Package Dimensions

GAS TURBINE MODEL	Titan 250	Titan 130	Mars 100	Mars 90	Taurus 70	Taurus 65	Taurus 60	Centaur 50	Centaur 40	Saturn 20
GENERATOR SETS										
Length, m (ft, in.)	18.1 (59' 6")	15.9 (52' 0")	14.5 (47' 8")	14.5 (47' 8")	11.3 (37' 0")	9.8 (32' 0")	9.8 (32' 0")	9.8 (32' 0")	9.8 (32' 0")	5.8 (18' 11")
Width, m (ft, in.)	3.7 (12' 0")	3.2 (10' 5")	2.8 (9' 2")	2.8 (9' 2")	2.8 (9' 2")	2.5 (8' 2")	2.4 (8' 0")	2.4 (8' 0")	2.4 (8' 0")	1.7 (5' 5")
Height, m (ft, in.)	4.2 (13' 6")	3.1 (10' 3")	3.1 (10' 0")	3.1 (10' 0")	2.8 (9' 2")	2.9 (9' 8")	2.8 (9' 4")	2.8 (9' 4")	2.8 (9' 4")	2.0 (6' 7")
Weight, kg (lb)	140 520 (310,000)	77 100 (170,000)	67 570 (160,000)	67 570 (160,000)	56 885 (125,405)	33 045 (72,700)	30 300 (66,900)	27 080 (59,700)	23 755 (52,370)	9980 (22,000)
MECHANICAL DRIVES										
Length, m (ft, in.)	10.3 (33' 9")	9.8 (32' 0")	9.0 (29' 6")	9.0 (29' 6")	7.9 (25' 3")	N/A	6.2 (19' 10")	6.2 (19' 10")	6.2 (19' 10")	4.0 (13' 2")
Width, m (ft, in.)	3.7 (12' 0")	3.0 (10' 0")	2.8 (9' 2")	2.8 (9' 2")	2.7 (9' 0")	N/A	2.5 (8' 2")	2.5 (8' 2")	2.5 (8' 2")	1.8 (5' 10")
Height, m (ft, in.)	4.2 (13' 6")	3.1 (10' 3")	3.0 (9' 6")	3.0 (9' 6")	3.1 (10' 3")	N/A	2.7 (8' 11")	2.7 (8' 11")	2.7 (8' 11")	2.2 (7' 5")
Weight, kg (lb)	50 620 (116,000)	34 020 (75,000)	27 200 (60,000)	27 200 (60,000)	20 140 (45,000)	N/A	15 880 (35,000)	14 970 (33,000)	12 700 (28,000)	4540 (10,000)

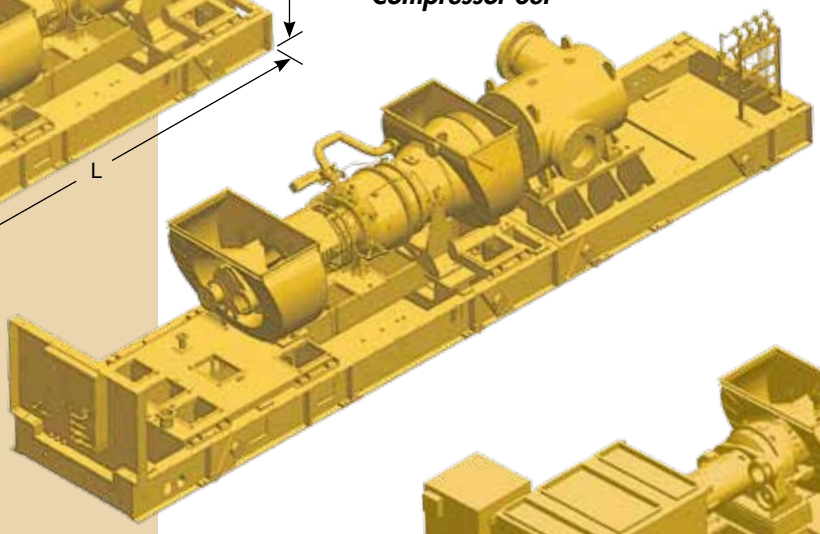
COMPRESSOR SKIDS - TYPICAL ADDITIONAL DIMENSIONS	ONE BODY	TWO BODY	THREE BODY
Length, m (ft, in.)	4.0 (13' 0")	5.8 (19' 0")	7.9 (26' 0")
Weight, kg (lb)	16 783 (37,000)	23 587 (52,000)	30 391 (67,000)

APPROXIMATE DIMENSIONS (unenclosed)

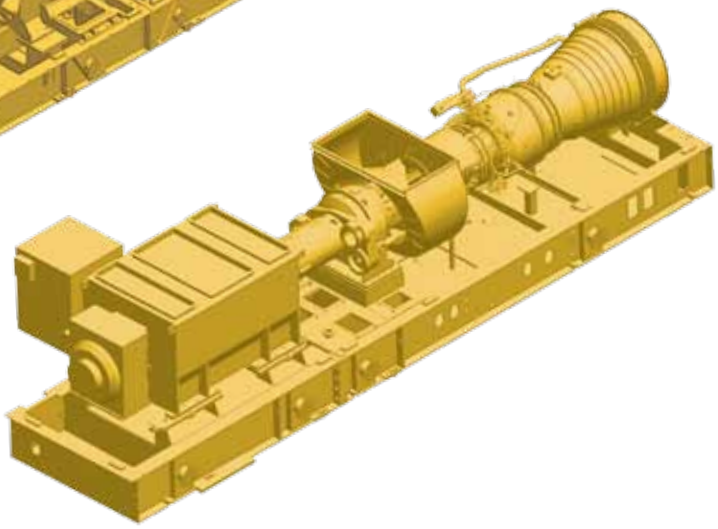
Mechanical Drive



Compressor Set



Generator Set



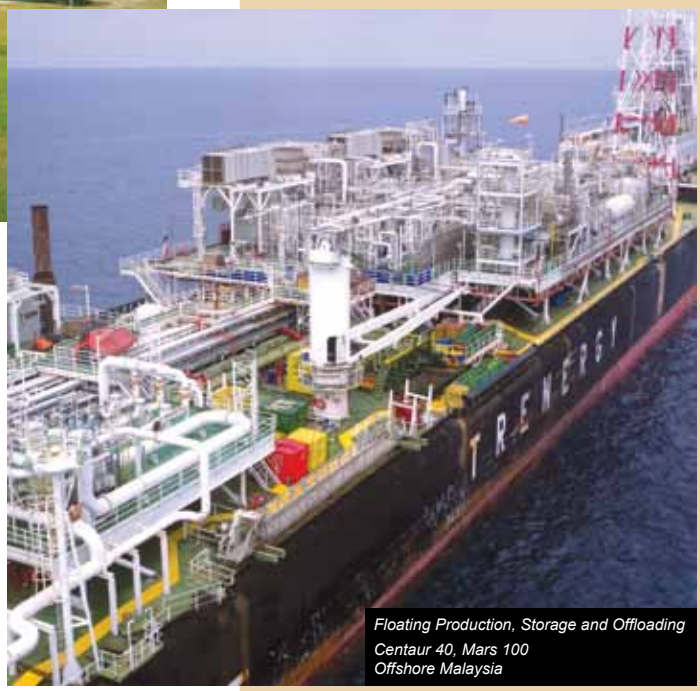
Typical Applications

Oil Field Power Generation
Taurus 60
Siberia, Russia

Gas Compression
Titan 130
Istanbul, Turkey

SPAR
Taurus 60
Gulf of Mexico, USA

LPG Production
Centaur 50, Mars 100
Kwinana, Australia



Floating Production, Storage and Offloading
Centaur 40, Mars 100
Offshore Malaysia

Gas Compression
EMDs
Shanghai, China

Expertise at a Project Level

Because we are totally focused on the industrial gas turbine market, Solar Turbines leads the industry in offering a multitude of application choices. We provide several key services that help facilitate the success of your project. From designing complete turnkey modular installations to providing customized financial services, Solar is your single source solution provider.

TurboFab Facility

Construction Services

Solar can provide single-source capability to design, build and commission a complete compressor station, power plant or offshore module for any number of fixed or floating platforms.

Single-Lift Module
Mars 90
Offshore India

Prefabricated Modules

Solar turbine packages are available in compression, mechanical-drive and power generation modules that can be installed and commissioned with a minimum of on-site work. Fully pre-engineered and prefabricated, these single- or multiple-unit modularized stations are self-contained, weatherproof and acoustically lined, and are especially well-suited for offshore and remote installations.

Financial Services

Financial Services

Working in conjunction with Caterpillar, Financial Services, other third party financial institutions and Export Import Bank, Solar offers a full array of financing products as options to customer direct purchase. Financing can be arranged for the gas turbine package or structured to include an entire turnkey plant, and terms can range from 1 through 15 years. Available financing options include discounted forfeiting transactions, loans, finance leases, operating leases, tax-exempt qualified leases, project financing and Ex-Im supported programs.

Worldwide Support Services

Field Service
Taurus 70

Field Service

- 43 strategic locations worldwide
- Fast response - around the clock
- Ready access to Solar's technical experts

Parts Support

- 7 days a week/24 hours a day ordering and shipment
- *Solar* certified service parts stocked at 9 depots worldwide
- 20 parts order locations, and 6 remanufacturing parts locations

Overhauls/Repairs/Upgrades/Uprates

- 8 overhaul facilities worldwide
- 8 exchange engine fleet locations worldwide - minimizing downtime
- 14 repair/overhaul facilities
- Remanufactured parts

Training

- All aspects of *Solar* turbomachinery systems
- More than 30 courses available
- At one of Solar's training facilities or your field site

Machinery Renewal and Upgrades

- Compressor restage and repair
- Power uprates
- Package refurbishment
- Controls retrofits

Exchange Engine
Titan 130

Machinery Management Services

Solar has developed a broad range of services we can customize to fit your needs including:

- Full-service operation and maintenance
- Fleet management
- Maintenance management
- Equipment health management
- Contract maintenance
- Consulting services
- Compression services
- Condition assessment
- Remote monitoring and diagnostics
- e-Collaboration

Remote Monitoring

Solar Turbines provides one-stop, full service OEM solutions through our global network of overhaul centers, parts depots, field service offices and training facilities. With support centers and knowledgeable personnel located around the world, Solar's Customer Services organization brings an uncompromising commitment to customer satisfaction by ensuring maximum productivity, extended equipment life cycle and reduced operating costs.

InSight System™, Solar's comprehensive online approach to equipment health management, includes the industry's most advanced remote monitoring and predictive diagnostics system. Using InSight System, maintenance is based on equipment condition rather than traditional time intervals. This saves time and money on maintenance and repair, resulting in more uptime, greater productivity, and optimized life cycle.

Solar® Turbines

A Caterpillar Company

Solar has been a pioneer in the design, manufacture and packaging of gas turbine systems for more than 60 years and is a world leader in the mid-range industrial gas turbine business. As a result, customers spanning the globe know they can rely on Solar to provide rugged, reliable turbomachinery systems, responsive service and unrivalled technical assistance and service parts availability anywhere in the world.

Solar Turbines Headquarters
San Diego, California

Packaging and Assembly
Kearny Mesa, California

www.solarturbines.com

For more information about *Solar* gas turbine-driven compressor sets, mechanical-drive packages, generator sets, and compressors or our broad range of customer support services, please contact your nearest Solar representative or visit us on the web at www.solarturbines.com

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