SOLAR TURBINES INCORPORATED

- World’s Largest Manufacturer of Industrial Gas Turbines (1 to 22 MW)
- Over 15,000 Gas Turbines Sold
- More than 2 Billion Fleet Operating Hours
- Installations in over 100 Countries
- Global Workforce ~ 8,000 Employees
- 48 Sales & Service Locations
- Based in San Diego, California, U.S.A.
- Direct End-to-End Sales & Service

Celebrating 90 year Anniversary!
CATERPILLAR INC.

- Global Parent Company since 1981
- Supports Solar’s R&D re-investments
- Deep Marine Experience
- Gives Solar access to wide range of innovations
**SOLAR’S HISTORY**

- 1927 - “Prudden” Airplane Company
- 1929 - “Solar” Aircraft Company
- 1940s - Jet Engine Afterburners and Small Gas Turbines
- 1950s - Aerospace Industry and Shipboard Power Generation
- 1960s - Servicing the Oil and Gas Industry
- 1970s - Beginning of the Offshore O&G Industry
- 1980s – Caterpillar purchases company
- 1990s - Technologies for Lower Emissions Levels and Higher Efficiencies

Solar has the experience providing reliable gas turbine power!
A WORLD OF EXPERIENCE

- Worldwide Coverage
- 840 Field Service Representatives (FSR)
- Multi Skilled FSR’s
  - Mechanical
  - Electrical
  - Controls
- 49 Regional Field Engineers
- 200 Technicians
- 115 Fleet Managers

<table>
<thead>
<tr>
<th>Gas Turbine Experience by Package</th>
<th>Units Sold</th>
<th>Est. Hours (000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressor Sets</td>
<td>4,690</td>
<td>921,600</td>
</tr>
<tr>
<td>Mechanical Drives</td>
<td>2,680</td>
<td>560,000</td>
</tr>
<tr>
<td>Generator Sets</td>
<td>8,120</td>
<td>1,092,900</td>
</tr>
<tr>
<td>Total</td>
<td>15,490</td>
<td>2,574,500</td>
</tr>
</tbody>
</table>

Effective: June 30, 2017 © Solar Turbines Incorporated
Note: Total includes >1,200 Spartans
Hours reflect new unit sales only.
A BROAD FAMILY OF PRODUCTS TO SERVE YOU

Saturn 20
1590 hp/1210 kW (Over 5040 Units)

Centaur 40 & 50
4700-6130 hp
3515-4600 kW (Over 3700 Units)

Taurus 60
7700 hp/5670 kW (Over 1990 Units)

Taurus 70
10,915 hp/7965 kW (Over 860 Units)

Mars 90 & 100
13,220 – 15,900 hp
9450 – 11,350 kW (Over 1390 Units)

Titan 130
20,500 hp/15,000 kW (Over 860 Units)

Titan 250
30,000 hp/21,745 kW (Over 50 Units and Growing)

Solar Turbines
A Caterpillar Company

Caterpillar: Confidential Green
TYPE APPROVED
A SIMPLE PROCESS TO MAKE ENERGY

Air is compressed

Power extracted into rotational energy

Fuel input

OUTPUT SHAFT

No Pilot Fuel
No Methane slip - Complete combustion
Burns no oil - Shaft bearings not in gas path
Fully automated monitoring and control
Dual fuel capable with full power change over
LOTS OF POWER - LITTLE SPACE

- Less weight
- More room for cargo

6 MW Gas Turbine Coupled with Electric Generator

17 MW Gas Turbine
TURBINE EXHAUST HEAT USED

Proven Steam Turbine Process

Base process

Cycle efficiency influenced by:
1. GT efficiency
2. GT inlet air temperature
3. GT inlet gas temperature
4. HRSG exhaust temperature
5. ST efficiency
6. Cooling water temperature/vacuum
7. Auxiliary consumption
8. Use of waste heat from oil cooler, generator cooler

Common auxiliary concept
1. Air cooled GT oil cooler
2. Air cooled GT generator
3. Water cooled ST oil cooler
4. Water cooled ST generator
5. Closed cooling water circuit

Solar Turbines
A Caterpillar Company
ONCE THRU STEAM GENERATOR

Simple and robust system compared to classic drum boiler

OSTG

Classic HRSG P&I D

Complicated

OTSG P&I D

Simple
POWER PLANT LOCATED WHERE YOU LIKE

Maximize Cargo Space!

- Gas Turbines
- Steam Turbines
- Recip (if needed)
ACHIEVE BETTER THAN 50% EFFICIENCY

Combined Cycle Power Plant Advantages

- Reduced fuel consumption
- Uses heat from engines, cold from LNG
- Reduced emissions
- Faster return on CAPEX investment
INCREDBLY CLEAN

DNV GL validated that gas turbines can significantly reduce marine emissions.
POWER LOAD CONSIDERATIONS

**Not True**
- A turbine powered ship will burn too much fuel at part load
  - Most fuel is burnt during transit

**True**
- Gas Turbines can run at 100% MCR continuously
- Gas Turbines can generate electric power rapidly
- Gas Turbines can run down to no power on terminal

Source: C:\Users\d38006\Documents\Marine\DNV LNG\2-Technical\Solar Drive Train Solution\Power Fuel Calculator 20170412JB
NOT COMPLICATED TO OPERATE

Designed for Unmanned Applications

One Week Operator Training

- System designed for minimum input
  - Automatic Starting to Operating Speed
  - Programmed Generator Controls
  - Normal and Malfunction Shutdown

- Protection
  - Continuous monitoring of all critical functions
OVERHAUL BY EXCHANGE PROGRAM

Engine Core Due In

Disposition

Parts

Subassemblies

Customers

Engines

Engine Shipped

Solar Turbines
A Caterpillar Company

Caterpillar: Confidential Green
OPTIONAL ENERGY STORAGE

Energy Storage as a Marine Solution manufactured by Solar Turbines Inc.

Can be combined with vessel’s energy production plant
- Eliminate emissions at critical times
- Rapid power for intermittent loads
- Smoothing efficiency curves

>> Configurable 250-1,000 kW; 1-8 hrs Discharge Duration
WHILE THE APPLICATION IS NOVEL, THE SOLUTION IS PROVEN

- Steam turbine
- Gas handling room
- Titan 250
- Reciprocating engines
RESULTS VALIDATED

- Solutions are real
  - 100’s hours engineering invested
    - performance
    - physical layouts
  - DNV GL simulation validated results
- Electrical Power Plant +50% efficiency

- Emission compliant Solutions
  - Future Proof Solution
  - Ultra low emissions
  - No methane slip
  - No EGA systems needed

Results show that greater than 5% IRR could be achieved
PERFECT !!
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Solar</th>
<th>Yard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine</td>
<td>Yes, dual fuel as option</td>
<td></td>
</tr>
<tr>
<td>Gearbox</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Oil tank</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Foundation</td>
<td>Yes</td>
<td>To ensure proper foundation supports</td>
</tr>
<tr>
<td>Fuel system</td>
<td>after LNG is gassified</td>
<td>LNG Storage and Regassification</td>
</tr>
<tr>
<td>Turbine Control System</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Bridge control</td>
<td>Optional</td>
<td></td>
</tr>
<tr>
<td>Coupling/Low speed shaft</td>
<td>Optional</td>
<td>Yes</td>
</tr>
<tr>
<td>Propulsor/waterjet</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Fire control</td>
<td>Optional</td>
<td>Yes as required by Class</td>
</tr>
<tr>
<td>Air filter</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Air ducting</td>
<td>Optional</td>
<td>Yes</td>
</tr>
<tr>
<td>Exhaust ducting</td>
<td>Optional</td>
<td>Yes</td>
</tr>
</tbody>
</table>
MORE THAN A ENGINE

• Fully operational system
AN INTEGRATED SYSTEM

Solar has deep experience creating a packaged solution to meet a variety of needs.
MEGAWATTS IN A BOX

• Fully enclosed option
  − Quiet 85 dBA
  − Gas and Fire detection/extinguishing