Outstanding performance available in SeaFloat application

With a proven, long-term track record of more than 7 million Equivalent Operating Hours (EOH) from over 350 successfully installed units all over the world, the SGT-800 gas turbine is an excellent choice for both, industrial power generation as well as oil and gas applications. It will meet your demand for excellent performance and efficiency, reliability and environmental compatibility at low lifecycle costs and the best possible return on investment. The SGT-800 will amend your combined cycle and cogeneration installations with its excellent efficiency and outstanding steam-raising capability. Designed for flexible operation it is perfectly suited for base and intermediate load as well as grid support. With SeaFloat SGT-800 all proven and well-known benefits are now available on floating devices.

The SGT-800 industrial gas turbine offers broad flexibility in fuels, operating conditions, maintenance concepts, package solutions, and ratings.

The high degree of modularization and delivery of pre-assembled and pre-tested plant modules minimizes the manpower required at construction yard as well as it is minimizing the hook up time at place of operation. The plant equipment is intended for on board installations based on international codes and standards valid for power plants. Marine adaptions are implemented to suit the marine environment with respect to, but not limited to air intake filters, materials, surface treatments and protection against water ingress and corrosion. Movements and deflection are addressed by particular technical modifications.

The combined cycle power plant provides highly efficient power output in a range from 150MW up to 450MW, depending on the plant configuration.

Key benefits

- 450MW(e) power output
- > 56.7% combined cycle efficiency
- More than 350 units sold
- More than 7 million fleet hours
- High reliability and availability
- Low lifecycle costs
- Robust dual-fuel (gas / liquid) DLE combustion system
- On-load fuel changeover capability
- Excellent fuel flexibility incl. ethane/propane
- High content of inert gases, hydrogen and heavy hydrocarbons
- Low emissions over a wide load range
- Capable of single-digit NOx
Architectural impression
Infographic

power output
depending on configuration
150 - 450 MW

high efficiency
up to
20% better LCoE
compared to reciprocating engines

pre-designed
plug&play concept

SGT-800
Architectural impression
SeaFloat Gas Turbine SGT-800

The SGT-800 gas turbines (GT) will be provided as a single lift package and 3-point mount installation, consisting of turbine, mechanical auxiliary systems, gear box, generator and generator switch gear. This concept allows fast and easy installation at shipyards and is designed to withstand nearshore conditions. The single lift package has a weight of approx. 265t and is pre-assembled and system tested with dedicated electrical and control module, weight 35t prior to shipment to the construction yard. It has a size of 22 m x 4.7 m x 5.3 m (length width, height). Factory performance testing can be conducted optionally upon customer’s request. Air intake filter house has a weight of approx. 20t and the weight of the GT enclosure ventilation system is approx.10t.

The single lift package concept enables 48h core engine exchange for plants with highest requirements on availability. The easy “roll out” capability of the gas turbine core engine enables on board maintenance and overhaul. On the core engine “roll out trolley” the core turbine is moved to the on-board overhaul area of approx. 175m² where an 8 ton gantry crane is used for turbine inspections/overhauls, Hot Gas Path Inspection (HGI) and Major Overhaul (MO) at every 30/60 thousand Equivalent Operating Hours (EOH).
SeaFloat Steam Turbine SST-600

Also the well proven SST-600 steam turbine (ST) will be provided as a pre-assembled and system tested single lift package on a 3-point mount base frame. It has a weight of approx. 475t. The steam turbine single lift package consists of steam turbine, condenser with evacuation systems, generator and generator switch gear. It has a size of 25 m x 7.0 m x 5.5 m (length, width, height). The turbine is directly coupled to the generator on the admission and has an axial steam exhaust.

Siemens in-house OTSG is generally available and thus the major components of the combined cycle power plant are provided from one hand, ensuring optimized design coordination.

Planned preventive maintenance is done onboard in the STG area. The area is covered by a building and includes a gantry crane with capacity for the various inspection activities.

(SST-600 in 2x1 configurations)

SST-600: 25.2 x 7.0 x 5.5 m (length, width, height)
SeaFloat OTSG

The Once Through Steam Generator (OTSG) will be provided as a package with maximum modularization. This modular approach has been applied in dozens of units worldwide and results in safer and better quality fabrication under optimized shop conditions. The arrangement enhances faster and smoother installation at the shipyard. The steel structure for the OTSGs are designed as one combined block, so a rigid structure is formed to withstand marine environment conditions and to minimize the footprint dimensions.

The OTSG is based on Siemens Benson Technology which incorporates a steam separator in the HP section of the boiler. With over fifty proven references globally, the steam separator provides power plants a secure start-up operation. The OTSG is of a robust design requiring low maintenance and inspections which can conveniently be performed during gas turbine inspections and overhauls.

The OTSG package has a weight of approx. 665t each. SCC-800 2+1 plant configuration has a size for the OTSG combined structure of 14 m x 23.6 m x 28 m. (length x width x height).
Foot print, main machinery

**SCC-800 2+1**
2xGT’s, 2xOTSG’s, 1xST with condenser, N+1 Feed water pumps, Feed water treatment system, Steam and feed water dosing and sampling system, 2xGas fuel preheaters, 2xEl&control containers GT’s, 1xEl&control container ST, 1x main two-winding generator transformer GT, 1xmain three winding transformers ST/GT, HV GIS switchgear

**SCC-800 3+1**
3xGT’s, 3xOTSG’s, 1xST with condenser, N+1 Feed water pumps, Feed water treatment system, Steam and feed water dosing and sampling system, 3xGas fuel preheaters, 3xEl&control containers GT’s, 1xEl&control container ST, 2xmain three winding transformers GT/GT & GT/ST, HV GIS switchgear

**SCC-800 4+1**
4xGT’s, 4xOTSG’s, 1xST with condenser, N+1 Feed water pumps, Feed water treatment system, Steam and feed water dosing and sampling system, 4xGas fuel preheaters, 4xEl&control containers GT’s, 1xEl&control container ST, 2xmain three winding transformers GT/GT, 1x main two winding generator transformer ST, HV GIS switchgear

<table>
<thead>
<tr>
<th>Plant configuration</th>
<th>Preliminary deck space requirement</th>
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<tbody>
<tr>
<td>SCC-800 2+1</td>
<td>~60x35m</td>
</tr>
<tr>
<td>SCC-800 3+1</td>
<td>~62x40m</td>
</tr>
<tr>
<td>SCC-800 4+1</td>
<td>~100x35m or ~57x54m depending on arrangement</td>
</tr>
</tbody>
</table>

Weights of main equipment

- GT’s, 295 tons each
- Gas fuel preheaters, 8 tons each
- ST with condenser, 475 tons
- El & control modules, 35 tons each
- OTSG’s, 665 tons each
- Steam cycle auxiliaries, 50 tons
- Main transformers, 1x130 tons, 1x 120 tons
- HV GIS switchgear, 20 tons
- Aux transformers and switchgears, 90 tons
- DCS & 110VDC UPS systems, <5 tons
Main features and performance information

- High GT reliability of 99.5%
- High GT availability of 98.7% with core engine exchange in 48 hours
- All maintenance possible on board
- High efficiency, refer to below table
- Dry Low Emissions (DLE)
- Low water consumption for steam cycle make up, minimal water treatment plant on board

<table>
<thead>
<tr>
<th>Configuration</th>
<th>2x1</th>
<th>3x1</th>
<th>4x1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net plant output*</td>
<td>149.4 MW(e)</td>
<td>224.4 MW(e)</td>
<td>299.3 MW(e)</td>
</tr>
<tr>
<td>Net plant efficiency*</td>
<td>56.6%</td>
<td>56.6%</td>
<td>56.7%</td>
</tr>
<tr>
<td>Net plant heat rate*</td>
<td>6,367 kJ/kWh</td>
<td>6,358 kJ/kWh</td>
<td>6,353 kJ/kWh</td>
</tr>
<tr>
<td>Number of SGT-800</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Steam turbine model</td>
<td>SST-600</td>
<td>SST-600</td>
<td>SST-600</td>
</tr>
</tbody>
</table>

Table: Typical Performance values.

<table>
<thead>
<tr>
<th>Emissions, NOx, [ppmV / mg/Nm3]</th>
<th>&lt;25 / 51.3 @ 15% O2 (50-100% GT load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions, CO, [ppmV / mg/Nm3]</td>
<td>&lt;5 / 6.3 @ 15% O2 (50-100% GT load)</td>
</tr>
<tr>
<td>Sea water temp. rise [°K]</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

Installed performance at:
- 25°C ambient air temperature
- 25°C sea water temperature
- 60% relative humidity

*) Gas fuel supply 30 Bar(a), 25°C, 48.6 MJ/kg LHV (Siemens standard gas composition). At generator terminals.

**) Gas fuel supply 30 Bar(a), 25°C, 48.6 MJ/kg LHV (Siemens standard gas composition). Including transformation and auxiliary losses. Excluding condenser cooling water pumps and auxiliary consumption of the barge, power ship or other structures.

Table: Emissions and Performance boundaries

SGT-800 based plants provide high combined cycle plant efficiency, even at part load operation, due to the unique part load control algorithm of the
SGT-800. Dry low-NOx single or dual fuel burners ensure low NOx emissions without need of water injection.

**Automation and control**

Highest degree of automation and control with fully automatized start-up and shut-down procedure provide an efficient and safe operation of the plant from an on-board control room as well as from a remote location e.g. from a load dispatch center.

Optimized operator and engineering environment has been considered with a large flexibility for localization in various operations rooms on-board the vessel/barge. Interfaces are available for any dedicated automation or control systems on board by means of OPC interface to superimposed systems, SCADA etc.

Data logging, compression and storage into history data base servers ensure the possibility to evaluate events and performance over time including valuable feature for maintenance planning. Connection to Siemens service centers for operations support and various services can be provided as part of service contracts.

**Typical project details**

A typical project is characterized as a floating or fixed off-shore power generation installation near to shore or moored to a jetty close to an electrical substation for import of the generated power via cable or overhead lines.

Basic design support from Siemens:

The combined cycle power plant (CCPP) equipment is to be installed onboard the vessel/barge with Gas & Steam turbine packages, OTSG’s, main transformers, HV switchgear and electrical and control equipment modules for turbines in a way suiting the vessel/barge. Siemens provides generic 2D/3D models as guidance towards an optimal layout.

The power plant is equipped with a highly compact and highly reliable Gas Insulated Switchgear (GIS), two incomers (2x1 & 3x1, three incomers for 4x1) from the generator transformers and one export feeder breaker for either cable or overhead line connection to an onshore tie in point. Optional configurations are possible.

Main Generator Circuit Breakers (GCB) for the gas and steam turbine generators are installed on the base frames of the turbine generator sets for 2x1, hence no separate generator switchgear structures are required.

Auxiliary power required for plant operation is derived from the auxiliary transformers. To keep the plant energized at plant stand still and for starting of the GTs, power is supplied from the HV grid via the main generator step up transformers. An on-board black start generator enables the start of the GTs even in the event that the grid had fallen black. Such black start generator is typically part of the onboard utilities and not part of Siemens scope.

Steam cycle auxiliaries, MV and LV switchboards, protection and DCS panels for the power plant are to be mounted onboard in dedicated equipment rooms.

The operation of the CCPP is based on the exhaust heat from the Gas Turbines without duct firing and without water injection for power augmentation. The robust Siemens standard DLE combustion system does not require water injection to meet the required low NOx emission levels, by this keeping the capacity of the water treatment plant low, which benefits the on-board layout.

The plant is intended for operation on gaseous fuel. Back-up operation with liquid fuel is available as an option.

An additional option is to equip the gas turbines with heat exchangers (glycol/water to air) in front of the gas turbine air intakes. By means of such heat exchangers, the inherent heat of the air assists vaporizing the LNG flow to the gas turbine. In turn, the air is cooled down which, in consequence, results in higher possible base load power output.
Should the regasification plant be designed not only for providing LNG to the Gas Turbines but to excessive amounts of re-gasified LNG e.g. to the on-shore gas grid the use of low grade heat from the steam turbine condenser for re-gasification is an efficient option. This option may increase the overall plant efficiency up to almost 90%.

The power plant consists mainly of the Gas turbines, the OTSG’s, and one condensing type Steam turbine with a sea water cooled condenser. All as per Siemens “Standard Reference Plant” (SRP) design for SCC-800 combined cycle installations. For further details please refer to scope of Supply and performance information below.

**Overview of Siemens obligation**

- Basic engineering for full power plant functionality and guaranteed performance
- SGT-800 gas turbine packages on common base frame with 3-point mount, fresh water-cooled lube oil and generator coolers.
- Electrical and control module with all electrical and I&C equipment for the GTG.
- Generator (GCB) and auxiliary power circuit breakers (ACB) as part of the GTG skid.
- All equipment prefabricated and pre-tested.
- Two dual pressure, OTSG’s of Once Through type
- Steam cycle auxiliaries, redundant feed water polishers, sampling and dosing equipment, redundant evacuation systems on steam and sea water side of the condenser, N+1 Feed water pumps
- One SST-600 condensing steam turbine on 3-point mount with axial steam exhaust, directly mounted condenser with enlarged hotwell, fresh water-cooled lube oil as well as generator coolers.
- Electrical and control module including all electrical and I&C equipment for the STG
- Generator GCB, generator and auxiliary power circuit breakers as part of the STG skid
- All equipment prefabricated and pre-tested
- Main step up transformers in three winding design for GT/ST combination, complete with protection relay system and on-load tap changer for ratio control on HV side. Fresh water cooling, OFWF
- Main step up transformer of two winding design for one GT, complete with protection relay system and on-load tap changer for ratio control on HV side. Fresh water cooling, OFWF
- Single busbar Gas Insulated HV Switchgear (GIS), two incomers from generator transformers, one outgoing export feeder (option two feeders) for cable or overhead line to shore, complete with protection and automations system integrated with plant DCS system
- Naturally air cooled epoxy insulated 7MVA auxiliary power transformers, 11 or 13,8/ 6,3 or 4,16 kV for 50/60 Hz systems, for mounting in transformer/switchgear room on board (11/13,8 kV supply from HV shore connection, starting power via main generator transformers and Auxiliary Circuit Breakers (ACB) on GTG skid)
- 6,3 or 4.16 kV switchgear for auxiliary power distribution to CCPP and utility consumers of the vessel. Two feeders are included as dedicated supply for the transformers and sub distribution of the vessel, normally not part of Siemens scope
- Naturally air cooled epoxy insulated 3 MVA 6,3 or 4,16/0,69 kV auxiliary power transformers for mounting in transformer/switchgear room on board
- 0,69 kV switchgear for auxiliary power distribution to CCPP consumers. Feeders for N+1 configuration of condenser cooling water pumps. Pumps and motors supplied by the yard. Naturally air cooled epoxy insulated 1 MVA 6,3 or 4,16/0,4 or 0,48 kV auxiliary power transformers for mounting in transformer/switchgear room on board
- 0,4 or 0,48 kV switchgear for auxiliary power distribution to CCPP consumers

Plant DCS for the above scope with engineering and operators stations for placing in a control room arrangement on board
- 110V DC UPS system for above scope
- 230VAC UPS distribution board, UPS supply from vessel main AC UPS system
- Supervision of installation at yard at daily rates
- Cold Commissioning supervision at yard at daily rates
- Training at yard at daily rates

Terminal points
- All terminal points on Siemens delivery scope at interface connections of packages and components

Overview of shipyard's obligation
- Installation of equipment
- Cold Commissioning of equipment (Under TFA, Technical Field Assistance by Siemens)
- Interconnecting piping and cabling between equipment
- Pipe and cable racks
- Supporting steel structures for equipment
- Platforms and stairs
- Weather shelter for the steam turbine including 85 ton gantry crane for maintenance
- Maintenance building (~175m²) for GT, including 8 ton gantry crane
- Electrical rooms for aux. power transformers and switchgears
- Rooms for installation of DCS UPS equipment, plant DCS panels
- MV/LV transformer(s) and sub-distribution for on board utilities
- AC UPS system for plant DCS
- Control room area and necessary furniture's
- Make-up water treatment/demineralization plant
- Service and instrument air system
- Fresh water cooling circuit for GT's, ST, main transformers and sampling rack for steam and water sampling

Siemens exclusions
- Any Marine society classification
- Design for Roll & Pitch, >3 deg.
- Design and materials for installation of equipment in hazardous area environment
- Shipment to yard
- Shipment from yard to final installation site
- Hot commissioning, performance test, trial run and customer training at customer site (can be separately offered on daily rates basis once scope and details are clarified)
Typical plant layout SCC-800 2x1 (~60x35m)
Typical plant layout SCC-800 3x1 (~62 x40m)
Typical plant layout SCC-800 4x1 (sequential layout: ~107x34m)
Configuration SCC-800 2x1, typical main flow diagram
Principal single line diagram SCC-800 2x1C

1) GT/GT module with HIGOS, Highly Integrated Generator Switchgear
2) HB1 Generator Switchgear
3) Transformer and sub-distribution, 0.4/0.48 kV by Yard
4) Option, Incomer panel for Black-start DG by Yard (2.5 MVA)
5) Option, Incomer panel for "Essential DG" by Yard (If long periods of "Black HV grid")
Principal plant DCS topology SCC-800 2x1C

Note 1: This drawing might describe, reproduce or relate to equipment outside Siemens scope of supply. This drawing shall only be used as a generic information.

Note 2: Physical computers in CCR will be placed in separate server cabinet.

Note 3: CCR building is not in Siemens Scope of Supply.

Note 4: Other Aux. system is not in Siemens Finspång Scope of Supply.
SGT-800 SeaFloat – off-shore “plug and play” power application
Benefits for yards and end customer

<table>
<thead>
<tr>
<th>Pre-engineered concept</th>
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<tbody>
<tr>
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<tr>
<td>• Pre-engineered “plug and play” equipment, including all main components for a complete power plant</td>
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<tr>
<td>• Optimized general plant arrangement provided in electronic format; 3D, 2D</td>
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<tr>
<td>• Performance and functional guarantees from Siemens</td>
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<tr>
<td>• Design once - build many =&gt; highest quality and lowest price</td>
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<tr>
<th>Installation advantages</th>
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<tr>
<td></td>
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<tr>
<td>• Optimized power plant footprint giving highest power density</td>
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<tr>
<td>• Siemens installation guidelines for yards</td>
</tr>
<tr>
<td>• 3-point mount single lift base frames with fastest installation of gas and steam turbine packages with small amount of supervision</td>
</tr>
<tr>
<td>• Gas and steam turbine packages are system tested with dedicated electrical and control modules before shipment</td>
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<tr>
<th>Best-in-class reliability &amp; availability</th>
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<tr>
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<tr>
<td>• World class reliability</td>
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<tr>
<td>• Optimized design for on-board turbine maintenance</td>
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<td>• Gas turbine core engine exchange in 48 hours for maximized availability</td>
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<tr>
<th>Excellent performance</th>
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<tr>
<td></td>
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<tr>
<td>• World class efficiency by Siemens well proven products</td>
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<tr>
<td>• Combined cycle power plant with highest turn down efficiency at plant part load</td>
</tr>
<tr>
<td>• High fuel flexibility; natural gas, ethane, propane, LPG, diesel</td>
</tr>
<tr>
<td>• Robust Dry Low Emission (DLE) combustion system</td>
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Flexible Long Term Programs

Siemens Long Term Service Program (FlexLTP) is tailored to support our customers achieving real outcomes:

- Operational flexibility, based on actual operation
- Tailored maintenance interval and aligned maintenance planning
- Priority service - Guaranteed mobilization time
- Project manager and maintenance planning services
- Remote on-line service and support
- Spare part management and spare part pool
- Forecasting of component life based on actual operation
- Access to continuous R&D activities in the area of failure pattern recognition & advanced diagnostic algorithm and tools
- O&M support on all levels up to complete organization
- Minimized cost of ownership (equipment condition based)
- Solid foundation for prediction of maintenance expenses
- Extensive guarantees
- Term warranty for replacement parts
- Combined agreement for Siemens rotating equipment if required

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