# Siemens Combined Cycle Reference Power Plant SCC5-4000F 2x1

**800 MW-Class 50 Hz**

Answers for energy.

SIEMENS

# Siemens SCC5-4000F 2x1 – The large and most advanced product to meet your power needs

Since its introduction in the mid-1990s, the Siemens Combined Cycle (SCC™) multi-shaft reference power plant SCC5-4000F 2x1 has become the plant of choice for large combined cycle power needs in the 800 MW-class in the 50 Hz world. Based on the long-proven modularized Reference Power Plant (RPP) approach, this product provides the flexibility to easily select options to meet specific site and customer needs. This, together with a pre-designed balance of plant, results in short project lead times. The combination of world-class gas and steam turbine technologies with trend-setting power plant system integration results in a highly efficient F-class plant that provides reliable low-cost electricity.

The design of the SCC5-4000F 2x1 reference power plant has been developed based on 50 Hz market needs. It provides an optimum balance between capital cost, plant performance, as well as operational and maintenance considerations. Pre-engineered modular options have been developed to further address individual needs, as well as life-cycle cost enhancements. Plant exhaust emissions are minimized by use of the proven Siemens dry low NOx Hybrid Burner Ring (HBR) combustion system.

The SCC5-4000F 2x1 is designed around advanced, well-proven and reliable Siemens equipment, including:

- Two Siemens Gas Turbines (SGT™) SGT5-4000F each connected to an air-cooled Siemens Generator (SGen™) SGen5-1000A
- One Siemens Steam Turbine (SST™) SST5-5000 connected to an air-cooled generator SGen5-1000A
- The Siemens Power Plant Automation system (SPPA™)

The use of identical air-cooled generators for the gas and the steam turbines removes the requirement for hydrogen handling and supply and improves asset management by reduced spares provision.

Significant plant improvements are achieved through a closed feedback loop with input from project execution and operation and maintenance experience into the reference power plant design. For example, the building/crane concept has been modified to increase lay down area and to reduce service time. As such, all main components can be serviced without mobile lifting devices. The installation of two cranes in the central hall allows simultaneous installation and service of steam and gas turbines. This not only simplifies erection, but also increases availability.

These, along with our expertise to design and build world-class combined cycle power plants ensure that your plant will remain a sound investment for many years to come.


# Modularity for plant flexibility

Our flexible scope of supply ranges from a Siemens Gas Turbine Package (SGT-PAC) to a full SCC™ Turnkey Plant. With our pre-engineered modular options, we can offer individual, high value solutions in every case, while paying particular attention to:

- Specific customer requirements
- Site requirements
- Statutory requirements

The RPP concept provides flexibility for highest customer benefit. It comprises a core with a high level of standardization and a flexible envelope to cover customer- and site-specific requirements.

In its base configuration the RPP includes the standard configuration, e.g. the most commonly asked for configuration. This provides a valuable, predefined wrap of core, options and variants to provide highest benefit for general application.

This configuration can be adapted to meet your individual needs (examples):

**Flexibility variants:**

- Different HRSG configurations

**Add-on/take-out options:**

- Back-up fuel
- Service package
- Pump redundancies
- Noise requirements

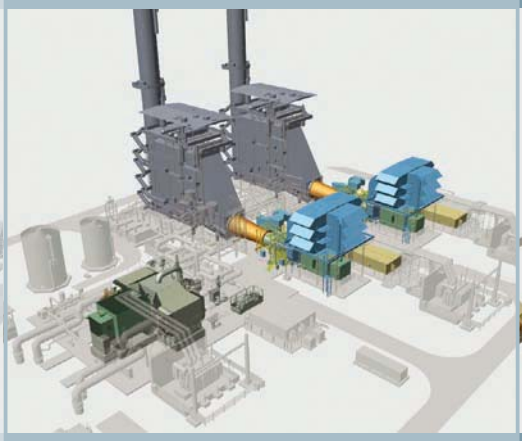
**Site-specific options:**

- Cooling configuration
- Additional water treatment

## SGT-PAC

*Gas turbine, generator, auxiliaries and controls for supplied scope, inlet and exhaust systems.*

## SCC Power Island



*SGT-PAC plus HRSG, steam turbine, condenser, major pumps, critical valves and controls for supplied scope.*

**Remark:**
Visible differences between Thermal Equipment and Power Island are small and therefore not shown

## SCC Turnkey

*SCC Power Island plus buildings, structures, plant cooling, power control centers, electrical, switchyard, fuel delivery, piping, plant control system, balance of plant construction, erection and commissioning.*

# Scope of supply

### SGT-PAC

- Gas turbines for fuel gas incl. auxiliaries
- Air intake/exhaust system
- Fuel gas system
  – Skids
  – Connecting pipes
- Gas turbine generators incl. auxiliaries
- Fire protection GT
- GT-electrical and I&C
- Options

**Performance/Delivery**

### SCC Thermal Equipment

**SGT-PAC**

- SST-PAC w/o condenser
  – Steam turbine incl. auxiliaries w/o piping
  – Generator incl. auxiliaries
  – ST electrical and I&C
- HRSG
- Options

**Cycle optimization/ Performance wrap**

### SCC Power Island

**SCC Thermal Equipment**

- Condenser incl. air removal system
- Boiler feed pumps
- Condensate pumps
- Critical valves
- Fuel pre-heater with filter, metering station, etc.
- Power Island controls
- Options

**System integration/ Optimized operability**

### SCC Turnkey

**SCC Power Island**

- Buildings/structures
- Cranes and HVAC (Turbine hall)
- Plant cooling systems
- Water treatment
- Raw water system
- Waste water system
- Tanks
- Plant piping/valves
- Electrical equipment
- Plant control system
- Additional fire protection/ fighting
- Erection/commissioning
- Further options

**Total EPC plant wrap**


# Plant layout

The main bay of the turbine building is one compact structural-steel building of simple rectangular design, which houses the gas turbine in transverse arrangement and the steam turbine and its generator in longitudinal arrangement. The steam turbine shaft is situated on a low elevation arrangement with side exhaust to the condenser. The near field noise emission of the main components is kept below 85dB(A).

The generators of the gas turbines are arranged in annexes to the turbine building. The inlet filter houses are located above these annexes. To ensure short electrical connections, the gas turbine and steam turbine related electrical and I&C equipment is located in pre-assembled Power Control Centers (PCCs) close to the respective generators.

The two condensers and the auxiliary components for the water steam cycle and the closed cooling water system such as coolers, pumps, air compressors and others are located in annexes along each side of the steam turbine building.

Two overhead cranes run the full length of the main bay of the building. They are capable to lift all the heavy equipment during erection, as well as parallel maintenance activities to reduce maintenance outage durations. An additional small crane in each annex further increases maintainability and reduces downtime.

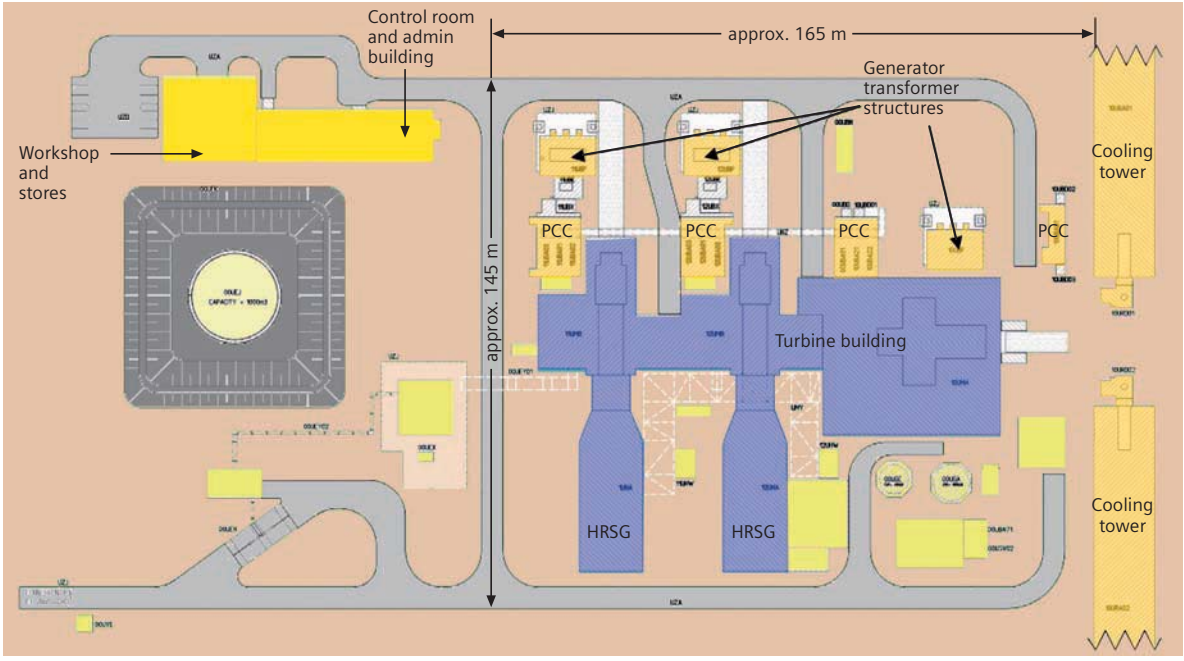
The HRSG's as well as the feedwater pumps are designed for outdoor installation and are arranged in line with the gas turbines. Gas filtering and metering equipment is adjacent to the HRSGs.

## Site terminal points

The SCC5-4000F 2x1 base design incorporates the following terminal point assumptions:

- Natural gas fuel supply at required conditions at the site boundary
- Raw, fire fighting and potable water from municipal supply at required conditions at site boundary
- Demineralized water tank hook up
- Effluent discharge to municipal connection at site boundary
- Electrical termination at high voltage bushing of the generator step-up transformer

# Plant arrangement




*The arrangement for the SCC5-4000F 2x1 reference power plant is shown with cooling tower cells. The cooling tower arrangement as well as the control room and administration building are typically site-specific.*

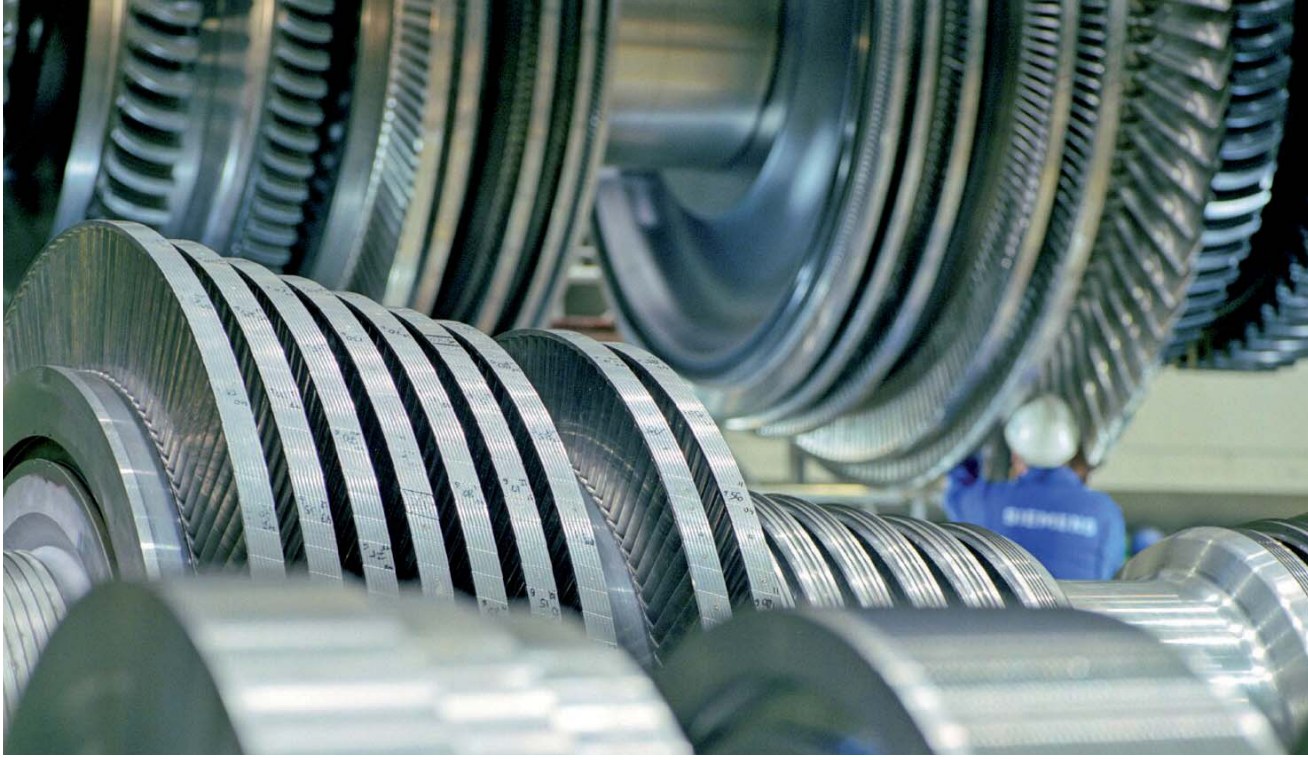
# Advanced turbine-generator technology

## SGT5-4000F gas turbine

Since its introduction in the mid-1990s, the SGT5-4000F has become the work horse of the 50 Hz fleet. Reliable and efficient, it is the most advanced proven gas turbine in its class today.

Features/benefits of the SGT5-4000F are as follows:

- Four-stage turbine for moderate stage loading
- Disk-type rotor with Hirth serrations and central tie bolt for rotor stability
- Low NOx Hybrid Burner Ring (HBR) combustion system for reduced environmental impacts
- Dual fuel capability (on-line transfer)
- Variable inlet guide vanes for improved part-load efficiency
- All blades removable with rotor in place for easy maintenance and shorter outages
- Unique design features for field serviceability



## SST5-5000 steam turbine

The SST5-5000 series steam turbine uses a combined high-pressure and intermediate-pressure element with a two-flow low-pressure turbine for a compact and economical arrangement.

The SST5-5000 is available with either single-side or dual-side exhaust to the condenser for simplified plant layout and ease of construction. The base design for the RPP incorporates dual-side exhaust.

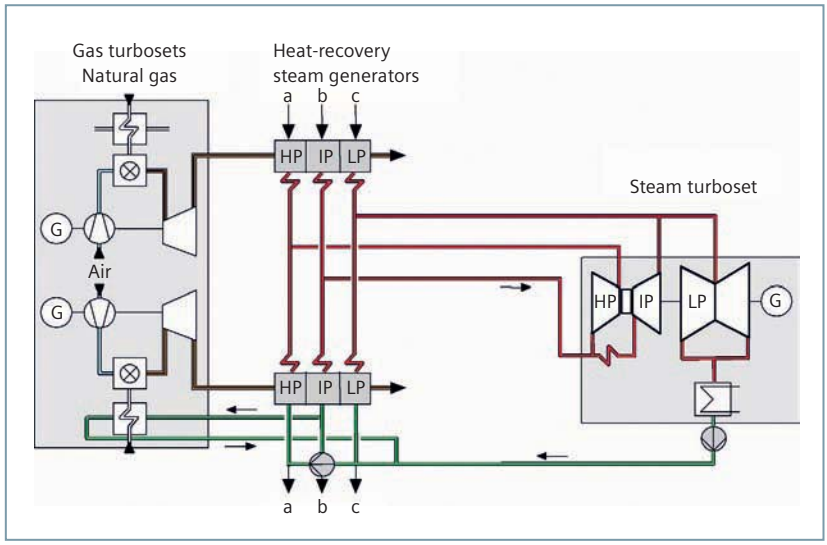
## SGen5-1000A generator

The air-cooled SGen5-1000A generator is one of the most efficient in the market today. Simple in design and easy to maintain, this generator type has proven to be highly reliable. It is shipped to the site pre-assembled to facilitate ease of installation. Identical air-cooled generators are used for gas and steam turbines.

# Plant design base and performance data

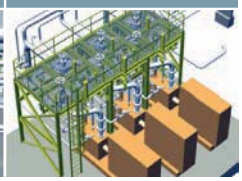
## Overview block schematic triple-pressure reheat steam cycle

The gas turbine cycle exhaust heat is used in the HRSG to generate steam for the steam turbine. In the base design a cooling tower is used to dissipate the condensation heat. Other configurations are available as pre-defined options. The triple-pressure reheat cycle with high gas turbine exhaust temperatures gives highest efficiency for combined cycle applications.




## Redundancy concept

RAM analyses have been conducted to determine the impact of redundancies of individual components on the plant availability based on economic evaluation. As an example the configuration with 3x50% pumps for condensate and feedwater proved to have a cost benefit for most applications and most operating regimes. A 2x50% option is available to suit customer preferences. Both configurations are supported by the flexible pump-island concept of reference power plant design to minimize impact on adjacent components.

| | Availability | Condensate pumps | Feedwater pumps |
|---|---|---|---|
| **Condensate pumps** 3x50% (base) vs. 2x50% | + 0.3% |  |  |
| **Feed water pumps** 3x50% (base) vs. 2x50% | + 0.5% | | |

## The advanced Siemens SCC5-4000F 2x1

The Siemens SCC5-4000F 2x1 is a new milestone in the sector of 800 MW-class 50 Hz combined cycle plants. The advanced SCC5-4000F 2x1 is not only one of the most powerful and efficient F-class plants on the market today, but even more important it is the most environmentally friendly with its significant reduction in emissions and water consumption. It builds on years of experience and includes feedback from executed projects to maximize availability. And with the incorporation of an integrated fast-start technology package, it adds one feature that has been missing in such plants to date, it eliminates the need to try to predict future operational regimes for the plant. It truly is the answer to meet all of your large 50 Hz combined cycle power plant needs in the future.

The use of our world-class gas turbine, steam turbine and generator technology combined with our expertise to design and build world-class combined cycle power plants helps to ensure that your plant will remain a sound investment for many years to come.

**The SCC5-4000F 2x1 is designed with the following conditions:**

| Boundary | SCC5-4000F 2x1 RPP base design |
|---|---|
| **Grid frequency** | 50 Hz |
| **Ambient temperature** | Design point 32°C (89.6°F)<br>Design range 5°C to 40°C (40°F to 105°F) |
| **Site elevation** | Design 0 m |
| **Fuel** | **Main fuel:** Natural gas, LHV: 50,012 kJ/kg (Methane at ISO conditions: 21,502 Btu/lbm)<br>**Back up fuel:** Fuel oil Cat.II, LHV: 42,600 kJ/kg/18,315 Btu/lbm |
| **Steam parameters** | 565°C/125 bar (1,050°F/1,815 psi)<br>565°C/30 bar (1,050°F/435 psi)<br>235°C/5 bar (455°F/75 psi) |

**With the mentioned boundary conditions the following performance is achieved:**

| Performance* | SCC5-4000F 2x1 RPP base design |
|---|---|
| **Net plant power output $P_{net}$** | **848 MW** (ISO ambient conditions, reference design) |
| **Net plant efficiency $\eta_{net}$** | **58.5%** (ISO ambient conditions, reference design) |
| **Net plant heat rate** | 6,158 kJ/kWh (5,836 Btu/kWh) |
| **Plant $NO_x$ emissions** | ≤ 25 ppmvd (Base load) |
| **Plant CO emissions** | ≤ 10 ppmvd (Base load) |
| **Plant $CO_2$ emissions** | 341.5 kg $CO_2/MW_{el}$ (Natural gas) |

* *Standard design; ISO ambient condition*

*Project and site-specific performance data for this and other Siemens combined cycle products can be obtained through SIPEP, the Siemens Plant Performance Estimation Program. For access to SIPEP please contact your Siemens sales representative.*

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