that remains intact longer also doesn’t have to be replaced as often, which reduces plant maintenance costs."

But the CHS won’t be all that was newly developed. The entire production process also was revamped. Production at the Berlin facility began in March 2006, after a record-setting construction period of only 12 months. "We’re using a process that’s unique worldwide. It includes producing the CHS material from raw materials in quantities precise to the gram, processing the material using special forming equipment, and firing the ceramic heat shields. The result is a precision-crafted CHS — with maximum variances in length and width of four-tenths of a millimeter," says Papadopoulos. "That’s a key advantage because the external suppliers use a different process to produce their heat shields, which then require reworking — and anyone who has ever reworked a ceramic knows how much work is involved."

Each individual heat shield is painstakingly inspected prior to delivery, and a shield that displays even the tiniest of fissures, for example, will be rejected. "Siemens also created a Total Quality Management System for this production line, which further improves the availability and safety of our gas turbines," reports Grote.

**Tailored Production.** If a CHS displays damage, the cause can quickly be found. That’s because each heat shield bears a number that designates its production process, in addition to ensuring the shield’s traceability. Later, each individual heat shield is also documented at PG in Berlin during "storing," which is what specialists call the process used to painstakingly fit the CHS into the annular combustion chamber. "The specified clearance between the two is about 1.4 millimeters, with a maximum tolerance of one-tenth of a millimeter. "Here we clearly see the benefits of the high-precision production process," says production chief Papadopoulos. But the greatest advantage of the new heat shield — innovative CHS geometries — is still to come.

"In contrast to external suppliers, we can cast the CHS in an extremely wide variety of forms. This means they will be suitable for applications not only in the area of the combustion chamber but also in other gas turbine components," says Grote. And the material itself also will be further improved to meet requirements in future generations of power generation plants. By the end of this year, the ceramic heat shields are to be enhanced with a corrosion protection layer, which will also be ceramic. As a result, the shields will be even more resistant to howling gases and scorching temperatures."

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**Unmatched Efficiency**

The world’s largest turbine, with an output of 340 megawatts, will enter trial service in November 2007. In combination with a downstream steam turbine, it will help ensure that a new combined cycle power plant achieves a record-breaking efficiency of more than 60 percent when it goes into operation in 2011.
Ceramic Coating. Siemens engineers have been creative in tackling this problem. One thing they did was lower the heat transfer from the combustion gas to the metal by applying a protective thermal coating consisting of two layers: a 300-micrometer-thick undercoating directly on the metal and a thin ceramic layer on top of that, which provides heat insulation (see p. 50). The blades are also actively cooled, as they are hollow inside and are exposed to cool airflows generated by the compressor. The blades at the very front (the hottest part of the turbine) also have fine holes, from which air is released that then flows across the blades, cooling them with a thin insulating film, like a protective shield. As turbine blades spin, massive centrifugal forces come into play. The end of each blade is exposed to a maximum force of 10,000 times the earth’s gravitational pull, which is the equivalent of each cubic centimeter of such a blade weighing as much as an adult human being.

The blades are made of a nickel alloy. These used to be cast and then left to harden. Later, crystallites were made to grow in the same direction as the centrifugal forces. But now the blades on the giant turbine in Irsching contain alloys that have mostly been grown as single crystals through the utilization of special cooling processes. They are therefore extremely resistant to breaking, as there are no longer any grain boundaries between the crystallites in the alloy that can rupture.

Engineers also optimized the shape of the blades, with the help of 3D simulation programs, whereby the edges were designed to keep the gap between the blades and the turbine wall as small as possible. As a result, prac- tically all the gas passes across the blades and is utilized. The blade-wall gap is made even smaller due to the turbine’s operation in a cone. This means that the shaft can be shifted several millimeters during operation until the blades nearly touch the housing — a practice known as “hydraulic gap optimization.”

Trial Run. Each off the measures mentioned above produces only a slight increase in efficiency or output. But taken together they add up to a new record. Whether or not everything works as planned will be revealed by the 18-month trial operation that will begin in November 2007. If preliminary test results are satisfactory, engineers will sign off on the new mega-
turbine in August 2008, allowing Siemens to begin marketing it. After successful completion of all tests in mid-2009, things will quiet down in Inching. The turbine will then be overhauled and disassembled, and all of its components will be thor-
oughly examined. If everything is found to be in order, the unit will be reassembled minus its specialized measuring equipment.

During the overhaul, engineers will install an additional steam turbine on the shaft at the end of the generator. The turbine will make use of the generator’s 600-degrees-Celsius gas to generate steam in a heat exchanger. Only through this combined cycle process can the energy in the gas be so effectively exploited as to achieve the record efficiency of 60 percent.

Conventional gas turbine power plants are generally pure-peak-load facilities that can be turned on and off as needed. The plant in Irsching is simply too good for that. “If the gas turbine proves itself during the trial period, we’ll as-
tend to use all of the plant in 2011,” says Alfred Beck from E.ON Kraftwerke GmbH. “It’s high ef-
ficiency will make it profitable for use in medium-sized generators, despite slightly higher gas prices.”

The facility will then generate electricity for between 3,000 and 7,000 hours each year, and will definitely be a superlative power plant.

Bernhard Gerl

Circuit Boards Go Green

Siemens researchers are making electronic compo-
nents more environmentally friendly. They’re elimi-

nating lead from soldering pastes and bromine-based flame retardants from some printed circuit boards. Fujitsu Siemens Computers is already selling PCs containing “green” circuit boards worldwide.

The environmentally friendly PCs, which are shipped all over the world, are an especially big hit in Scandinavia, not least due to the fact that the new Nordic Swan environmental certificate requires adherence to very strict standards — and the Green PCs are currently the only com-
puters to have received such certification.

FSC sold more than 1.3 million Green PCs worldwide last year — even though private cus-
tomers are still able to purchase them. “Our normal PCs can compete at retail prices because many elements are bought in from the outside. But unfortunately, those components still con-
tain bromine,” Riegler-Rittner explains.

Materials issues are also the focus of work conducted by Dr. Klaus Peter Galuschki. For years, Galuschki and his team at Siemens CT in Berlin have been assessing the quality of lead-
free soldered circuit boards and optimizing the processes for manufacturing them. “Character-
stics such as lifespan, stability, and electrical