High Efficiency Solutions
Solutions for your power plant optimization

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Optimize your plant with Siemens High Efficiency Solutions

As a leading supplier of combined cycle power plants, Siemens has comprehensive expertise to engineer, construct and commission world-class combined cycle power plant solutions that reach the highest efficiency levels together with a high level of flexibility and environmental compatibility. We have proven this experience and expertise through over 1,500 Siemens power plants currently in commercial operation worldwide.

All of our High Efficiency Solutions are optimally harmonized and can be freely combined according to our building block approach. This allows for not only a highly efficient power plant solution, but for a solution designed specifically to meet the customer’s individual needs.

On the following pages you can learn more about our High Efficiency Solutions and their operational, environmental and economic benefits.

The changing demands on fossil-fired power plants

Balance your plant

Competition within energy markets is becoming increasingly more competitive in many regions across the world. Factors such as low fuel costs for coal and nuclear, must feed-in rules from renewable energy, plus the downward trend of electricity prices can make plant profitability a serious challenge. Siemens High Efficiency Solutions are designed to maximize plant efficiency while maintaining the flexibility needed to operate in any type of market condition.

Siemens combined cycle power plant capabilities go beyond meeting operational requirements - they enhance the economic benefits of the plant. By designing each system of the plant to work together as a whole, the result is a highly efficient plant that will reflect directly to plant profitability.

In addition to high efficiency, today’s complex and challenging market requires additional capabilities to remain competitive. Siemens combined cycle power plants are built with these factors in mind, able to balance supply and demand with fast response, and through eco-friendly means. This results in the perfect combination of high-efficiency without compromising flexibility or environmental compatibility.

We offer all of these capabilities while maintaining the traditional benefits of gas-fired combined cycles - economic, low emission, reliable power generation. Having a plant that can do everything well, maximizes the potential for revenue generation over a long plant life cycle.
High Efficiency Solutions

Steam Bypass
Replacement of the high pressure super-heater & reheat intermediate water injections by HPSH & RH steam bypasses

Low Loss Pumps
Speed controlled feed water pumps serve the plant requirements while saving auxiliary power

Low Loss Transformer
Use of generator transformers with minimized losses increases the overall plant efficiency

Wet Compression
Compressor intercooling for increased capacity

Evap Cooling
Cooling the gas turbine inlet air

Air Preheater
Reduce fuel heat input by increasing gas turbine inlet air temperature

Air Preheater
The air preheating (APH) solution increases the part load efficiency, enables lower emission compliant load levels (MEL), and provides efficient GT anti-icing in a single system.

The fuel heat input is reduced by increasing the gas turbine inlet air temperature with low-caloric steam. The air preheater skid uses low pressure steam from the HRSG to warm up antifreeze water, which then transfers heat to the gas turbine inlet air.

Challenge | Solution | Benefits
--- | --- | ---
| | | • More efficient cycling operation

| | Increase part-load operation |
| | Merit Order prefers efficient power plants |
| | Improve plant operation costs |
| | Maintain high plant availability |

Net efficiency at 50% CC load
Payback period at 8,000 h/a operation

Note: Actual benefit is dependent on plant configuration, operational profile and local market conditions.

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Operational and economic benefits

Our high efficiency solutions provide added value for the customer and increase the overall plant profitability from day one of operation, leading to quick amortization and short payback periods for the additional investment.

High efficiency combined cycle power plants provide a significant competitive advantage for the operator compared to conventional plants.

Over the past several years, environmental sustainability has become a key requirement for power plants worldwide.

The increased use of highly efficient combined cycle power plants instead of less environment-friendly generation technologies can make a significant contribution to the world's ambitious climate targets. Our high efficiency solutions can help to protect the environment and leave a cleaner planet for coming generations.

Case study

Our Dangjin 3 power plant uses Siemens technology for maximum efficiency and flexibility. It is the best available on the market.

W.K. Lee
CEO of GS EPS, Korea

The Dangjin 3 combined cycle power plant in South Korea has an efficiency of almost 61% thanks to Siemens’ world record-breaking H-class gas turbine and the special steam cycle.

Location: Dangjin3, South Korea
Customer: GS EPS Co. Ltd.
Plant type: SCC6-8000H 1S
Power output: 415 MW

Special features:
- Efficiency of almost 61%
- Most efficient combined cycle power plant in Asia at day of commissioning
- High level of operational flexibility
References

Our High Efficiency Solutions consist of a wide range of single technical measures and improvements, each of which helps to increase the overall plant efficiency. Here are some of our project highlights!
Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.
Appendix

Overview pages for print

Every solution on one page
Steam Bypass

The common high pressure superheater and reheat steam temperature control is carried out by intermediate and final water injection systems. The HPSH and RH steam bypass system shall take over the objective of the intermediate water injections.

**Challenge**
- More efficient cycling operation
- Increased part load operation
- Merit Order prefers efficient power plants
- Improve plant operation costs
- Maintain high plant availability

**Solution**
- Replacement of the high pressure superheater (HPSH) & reheat (RH) intermediate water injections by corresponding HPSH & RH steam bypasses
- For normal operating range (load change) the steam turbine temperature control is only carried out by Steam Bypasses
- The final HPSH and the final RH water injection are only in operation during start-up

**Benefits**
- Improvement of CC efficiency
  - in part load operation
  - in base load operation at higher ambient temperatures
  - during start-up
- Improve the plant efficiency at base load operation in case superheater/reheater surfaces have been oversized
- Increased HRSG stability in part load operations
- Reduced maintenance and service cost
- Reduced global warming potential by lower emissions

Note: Actual benefit is dependent on plant configuration, operational profile and local market conditions.

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Low Loss Pumps

Typically, feed water pumps with fixed rpm deliver more pressure than required. A frequency converter adapts the speed to the plant requirements while saving auxiliary power.

Challenge
- Combined cycle power plants are operating more frequently in intermediate and peak load
- Minimize auxiliary power in part load operation
- High fuel costs require optimized efficiency

Solution
- Use frequency converter with allocated transformer for speed control of feed water pump
- Adjust feed water system control concept by optimized pump operation
- Alternative solution: hydraulic speed coupling

Benefits
- Higher plant efficiency during part load
- Lower fuel consumption during part load operation
- Reduced wear of pump, partly due to optimized pump operation
- Less mechanical and thermal stress for motor because of reduced starting current at a soft start with frequency converter

Efficiency increase via frequency controlled Low Loss Pumps

Net efficiency at 50–60% CC load 0.2%-pt.

IRR period at 8,000 h/a operation 13%
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Low Loss Transformer

Using generator transformers with minimized losses increases the overall plant efficiency.

Challenge

• Improve plant profitability
• Higher plant efficiency and output by reduced losses
• Improve the ecological footprint of the plant, fleet and company

Solution

• Application of latest material efficient design and technology
• Use of advanced magnetic core material with optimized layer thickness
• Use of high-grade conductor material with optimized cross sections
• Apply efficient cooling system

Benefits

• Increased plant profitability through lower losses
• Reduction of electrical and electromagnetical losses
• Less waste heat
• Less noise emission
• Reduced magnetic fields

IRR period at 8,000 h/a operation 17%
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Wet Compression

Wet Compression is a proven technology to increase the capacity of gas turbine for peak load operation or to recover deficits in summer time.

Challenge

- Upgrade peak load gas turbines
- React to increased grid power demand (i.e. during summer peaks or grid fluctuations)
- Recover performance deficits in summer time
- Enable response on short term capacity needs

Solution

- System for compressor intercooling
- Get fine water droplets well distributed into the compressor
- Evaporation inside the compressor
- Inlet cooling

Benefits

- Power increase of up to 18% depending on the frame and operational requirements
- Up to 3 % gas turbine heat rate improvement
- Higher exhaust energy for increased steam production
- Greater operational flexibility
- Reduction of the NOx-emissions
- Higher gas turbine efficiency

Wet Compression
High Efficiency Solutions

Evap Cooling

Cooling of the gas turbine inlet air leads to increased power output and an improved gas turbine heat rate, particularly in warm and dry climate regions.

Benefits

- Improve gas turbine performance
- Lower electricity consumption
- No demineralized water required - most region's local water supply is sufficient
- No continuous wetting of plenum, ducts and GT with droplets
- Acts as additional inlet air filtration
- Reduced noise emission

Challenge

- High demand of electricity in warm and dry climate regions
- Deterioration of power output and efficiency of gas turbines with increasing ambient temperatures

Solution

- Reduction of intake air temperature by adding moisture
- Process based on water evaporation
- Decreasing the inlet air temperature increases the density of the air
- Equally suitable for new power plants and for existing facilities

Up to 10% Power increase

Net energy output operation 860 MWh/a

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Air Preheater

The air preheating (APH) solution increases the part load efficiency, enables lower emission-compliant load levels (MEL) and provides efficient GT anti-icing in a single system.

**Challenge**
- More efficient cycling operation
- Increased part load operation
- Merit Order prefers efficient power plants
- Improve plant operation costs
- Maintain high plant availability

**Solution**
- Reduce fuel heat input by increasing GT inlet air temperature with low caloric steam for higher plant efficiency
- APH skid uses low pressure steam from HRSG to warm up antifreeze water, which then transfers heat to the GT inlet air

**Benefits**
- Higher efficiency resulting in fuel savings and enhanced competitiveness in part load operation
- Reduction of global warming potential by lower emissions
- Enables lower MEL level
- Efficient GT anti-icing operation without using compressor air

Air Preheater with low calorific steam increases part load efficiency