Omnivise Digital Services Portfolio

Plant Optimizer

for Combined Cycle and Steam Power Plants

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siemens.com/digital-services-energy
Omnivise Digital Services Portfolio

By itself, Big Data doesn’t generate insight. Insight requires an expert knowledge and understanding of how best to leverage those analytics.

Using our powerful new digital toolbox, our Siemens Omnivise Digital Services Portfolio team provides data-driven, tailored services, so your operations and maintenance teams will have the information and confidence they need to make timely, insightful decisions.

Omnivise Digital Services Portfolio is running on MindSphere, our cloud-based, open IoT operating system that combines new developments in data analytics, connectivity, and cyber security with proven capabilities for remote maintenance and optimization.

For utilities looking to increase revenue and reduce costs, Siemens Omnivise Digital Services Portfolio provide insights based on data to help you operate more flexibly and respond quickly to a rapidly changing market.

Analyze Advise Optimize

Data

Monitor

Advisor

Optimizer

Expertise in Content

Provides full transparency for your plant. Our monitor solution aggregates and visualizes your machine data. Functions for analytics, KPIs, dashboards and trends are part of the solution.

Expertise in Content

With our advisor solutions, we help you to find the best measures to improve your plant. Our data-driven recommendations help you in your decision-making process.

Expertise in Implementation

With our solutions for performance optimization, we can help to increase the efficiency, availability or flexibility of your assets, or lower your emissions.

Solutions suitable for any plant

Waste Incineration Plants
Combined Cycle Plants
District Heat Plants
Industrial Power Plants
Biomass Plants
Solar Power Plants
Fossil fired Power Plants
Desalination Plants
Coal Gasification Plants

Operates with any type of DCS

Basic automation third-party DCS

Partial modernization incl. optimization for third-party DCS
The importance of Performance Optimization

In the competitive power-generation market, power utilities are focused on optimizing performance while minimizing operational costs to deliver low-cost, high-quality energy to their customers. However, there needs to be a balance in the trade-offs between performance, operational costs and risks. When it comes to fossil generation, performance optimization is directly related to operations cost. Using the data from the DCS for advanced control concepts without major changes to mechanical equipment is one of the options to increase your plants profitability. With Siemens Plant Optimizer – part of the Siemens Omnivise Digital Services Suite, you can adapt plant operations to your current requirements.

Click to select your plant type

Click to choose your solution

Combined Cycle Power Plant  | Steam Power Plant  | all

High Availability

Low Emissions

part of the Omnivise Risk and Compliance suite

High Efficiency

part of Flex-Power Services™

High Flexibility
Low Loss Start for SPP

Minimizes fuel consumption during the startup process while ensuring that thermal stresses for thick-walled components do not violate permissible limits. In most cases, a further bonus in addition to reduced fuel consumption is a significant reduction in startup time.

Solution | Benefits
--- | ---
Model-based creation of set points for main steam pressure, temperatures and firing rate, making maximum use of permitted thermal stresses for thick-walled components
Automatic startup of boiler and turbine with bumpless transition to coordinated power operation

The Low Loss Start solution optimizes and coordinates the components essential for plant startup.
High Availability Solutions

Life Time Plus for SPP

Regardless of all the demands for high efficiency and flexibility, low-stress operation remains a fundamental requirement.

Thanks to its model-based and predictive feedforward control, this solution enables stable and precise load changes with minimum fuel overshoot. This minimizes wear and tear on plant components.

**Solution**

- Adherence to permitted thermal stress limits on startup
- Optimized soot blowing
- Laser-based measurement of concentrations critical for fire-side corrosion and optimal combustion control based on this information

**Benefits**

Even with the most stringent efficiency and flexibility requirements, components are operated in a low stress regime.
Low Emission Solutions

Select your plant type

Solutions for SPP

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>NOx Reduction</th>
<th>CO2 Reduction</th>
</tr>
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<tbody>
<tr>
<td>SPP</td>
<td>Lower emissions as a result of improved combustion</td>
<td>Reduction of emissions as a result of improved efficiency</td>
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**NOx Reduction for SPP**

Reduce NOx emissions without running the risk of fire-side corrosion due to localized lack of air.

**Solution**

- Laser-based measurement of temperature and concentration (e.g. H2O, O2, CO) averages directly in the combustion zone
- Calculation and evaluation of temperature and concentration distributions based on computer-aided tomography (CAT)
- Robust combustion control using model-based controls

**Benefits**

**Temperature profile in combustion zone over boiler cross-section**

*Before* and *After*

Reduction of NOx emissions based on changes to combustion; example of temperature profile is shown here.
High Flexibility Solutions

Select your plant type

Solutions for SPP

**Fast Start**
- Get back on the grid faster

**Frequency Control**
- Increased range for primary frequency control

**Dispatch Control**
- Larger load window for grid dispatcher

**Maximum Load Plus**
- Electrical output increased to above 100%

**Minimum Load Reduction**
- Reduced minimum load level

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**Fast Start for SPP**

Get the unit back on the grid in the shortest possible time without allowing thermal stresses in thick-walled components to violate permissible limits.

- Model-based formation of set points for main steam pressure, temperatures and firing rate, making maximum use of permitted thermal stresses for thick-walled components of boiler and turbine
- Automatic startup of boiler and turbine with bumpless changeover to coordinated power operation

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The Fast Start solution optimizes and coordinates the components essential for power plant startup.
Process Optimization Monitor and Advisor

The cloud-based Process Optimization Monitor and Advisor uses thermodynamic analysis of flue gas data to indicate optimization potential with respect to efficient and stable plant operation with reduced CO/NOx emission and excess O2.

Free dashboards provide a quick overview of plant health and benchmark position. With our premium services you get an analysis of your plant data and recommendations for improved operation, e.g. setpoints as well as the optimization potential.

Fast and Easy Implementation

Our 4-step approach:

1. **Initial Assessment**
   Determine solution modules to fit individual needs / requirements

2. **Data Analysis**
   Identify, localize and quantify existing potential

3. **Evaluation**
   Present proposed solution including estimates of potential return on investment (ROI)

4. **Implementation**
   Engineering based on comprehensive process and owner plant know-how
References

Our performance optimization solutions have been implemented in more than 270 plants in 29 countries worldwide.
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

Selected references and solution overviews for print
Omnivise Digital Services Portfolio

Power Plant Optimizer for Steam Power Plants

High Efficiency Solutions

Low Loss Start
Minimizes fuel consumption during the startup process while ensuring that thermal stresses for thick-walled components do not violate permissible limits.

Temperature Optimizer
Optimizes control actions by the various final control elements used for temperature control during startup and over the entire load range.

Best Point
Performs continuous analysis, monitoring and optimization of the overall process and key components.

Combustion Optimizer
Utilizes data from the laser-based measurement to control the combustion process and combines the advantages of modern model-based control strategies and neural net based approaches.

Sootblower Optimizer
Calculates the optimum time for soot blowing for each separate soot blower group as a function of current condition of the associated heat exchange surfaces.

Low Throttling
Reduces the degree of throttling for turbine valves, feedwater control valves and fan vanes for forced- and induced-draft fans to the amount actually needed to permit these to meet dynamic response requirements.

High Availability Solutions

Life Time Plus
Enables through model-based and predictive feedforward control stable and precise load changes with minimum fuel overshoot. This minimizes wear and tear on plant components.
Fast Start
Get the unit back on the grid in the shortest possible time without allowing thermal stresses in thick-walled components to violate permissible limits.

Frequency Control
Upgrades the unit so that it can provide primary frequency control and spinning reserve. Due to the fast load ramps that this service requires, it places very high demands on the dynamic control response of a power plant unit.

NoX Reduction
Reduce NOx emissions without running the risk of fire-side corrosion due to localized lack of air.

CO2 Reduction
Reduces CO2 emissions, thus increasing the number of excess emissions credits for trading.

Dispatch Control
Upgrade the unit so that it can provide increased secondary frequency control capability. Implementing faster load change rates will open up a larger window for high-return secondary frequency control services.

Maximum Load Plus
 Allows the steady-state output of the plant to be increased to up to 110% for unchanged feedwater and main steam mass flow under fully automatic control by controlled deactivation of HP feedwater heaters.

Minimum Load Reduction
Reduces specified minimum load level and makes the plant capable of fast and low-stress load increases on demand in accordance with market requirements.

Low Emission Solutions
Low Emission Solutions

High Flexibility Solutions
High Flexibility Solutions

CO2 Reduction
Reduces CO2 emissions, thus increasing the number of excess emissions credits for trading.

Dispatch Control
Upgrade the unit so that it can provide increased secondary frequency control capability. Implementing faster load change rates will open up a larger window for high-return secondary frequency control services.

Maximum Load Plus
Allows the steady-state output of the plant to be increased to up to 110% for unchanged feedwater and main steam mass flow under fully automatic control by controlled deactivation of HP feedwater heaters.

Minimum Load Reduction
Reduces specified minimum load level and makes the plant capable of fast and low-stress load increases on demand in accordance with market requirements.
#### High Efficiency Solutions

**Low Loss Start**
Repeatable startup of CCPP unit with minimum losses and without thermal stresses violating permissible limits for thick-walled components.

**Temperature Optimizer**
Achieves maximum steam temperatures without violation of material limits.

**Best Point**
Operates unit at maximum efficiency.

#### High Availability Solutions

**Life Time Plus**
Operate the plant in a low-stress mode during plant start-up and load operation so as to maximize plant lifetime.
Low Emission Solutions

Emission Control
Reduces emissions, allowing sale of excess emissions credits.

High Flexibility Solutions

Fast Start
Reproducible startup of CCPP in the shortest possible time without thermal stresses violating permissible limits for thick-walled components.

Frequency Control
Provides primary frequency control and spinning reserve at maximum steady-state unit load and with low-stress operating mode for gas turbine(s).

Dispatch Control
Upgrades the unit to provide secondary frequency control capability (AGC) under dispatcher control and to open up a larger window for automatic load dispatch.

Maximum Load Plus
Increases steady-state unit load with simultaneous provision of primary control reserve.

Flex-Power Services™
Provides hard- and software solutions as well as studies and plant assessments. The solutions will often be influenced by the overall plant rather than individual components only.
The Plant
The Cogeneration plant Nossener Brücke is operated by DREWAG, the local utility company for the city of Dresden in Germany. With an output of 1,700 GWh/a, this combined heat and power plant provides up to 80% of the district heat supply to the city. The plant comprises three SGT-1000 (V64.3) Siemens gas turbines with down-stream heat recovery steam generators. The plant is in operation year round and regular plant outages are not scheduled. In general the heat requirements of the customers in the heat network essentially determine the operating mode of the plant. In addition the capabilities of optimized operation that are offered by the use of a thermal storage module are also employed.

The Task
The objective is to equip the plant for the marketing of system services so that both primary and secondary frequency response could be marketed in future. Additional restrictions result from the gas load management plan for the avoidance of gas purchase peaks. The stress on the gas turbines shall also be kept at a low level. In addition a low-stress control concept for district heat balancing had to be elaborated and implemented.

The Solution
Adjusting the steam turbine inlet valve is a proven method in coal-fired power plants and has been applied in a combined-cycle power plant for the first time in this project. This concept involves using the main steam system as a steam storage module which the steam turbine can use to implement fast load changes. In this case, the gas turbines are only operated slowly and with low plant stressing as a consequence. Siemens implemented a coordinated unit control which matches the output of the gas turbines with the steam turbine. Up to now, gas turbines have controlled the output while the steam turbine operated either with the valves wide open or in inlet pressure mode.
The new coordinated unit control has proven successful in practice, permitting a dynamic operating mode which can be adjusted in line with the requirements but which is nevertheless stable and incurs low stresses. The implemented capabilities and the increase in flexibility have future-proofed the plant and enabled it to adapt better to changing market conditions.”

Axel Pechstein, Power Plant Manager, DREWAG - Stadtwerke Dresden GmbH

The Results

- Increased plant efficiency

- Flexible adaptation to the regulations of the power market

- Increased flexibility making the plant future-proof

The latter has been retained and the pressure set-point has been piloted such that the steam turbine throttles and generates the required output in the event of a primary frequency response (PFR) event. Siemens Performance Optimization models are used here which calculate the throttling and the dynamic pressure characteristic in the event of a primary frequency response event based on the gas turbines that are in operation and the required PFR quantity. With the future-proof Siemens Unit Control, plants operated under heat extraction control can also satisfy the flexible requirements of the power market.

DREWAG - Stadtwerke Dresden GmbH
These measures are all part of Flex-Power Services and can in many cases be provided as a retrofit for the Siemens service fleet and combined with other Siemens' modernizations. Implementing these state-of-the-art features can help power plant components, such as steam and gas turbines and generators, remain reliable and increase the competitiveness of the plant in the changing energy market within your region.

Your benefits
Carrying out a site specific assessment can provide you with recommended options for cost-effectively upgrading your power plant to increase its operational flexibility.

Flex-Power Services measures can offer you quantifiable technical and financial benefits. These can help you improve the overall performance and operational flexibility of your power plant by integrating various technical solutions in a cost effective manner.

Depending on your technical requirements, Siemens Energy can offer you the Flex-Power Services designed to:
• Reduce minimum part load
• Increase efficiency in part load operation
• Allocate peak power
• Optimize load gradients
• Provide faster start-up and enhanced start & stop performance
• Increase maintenance flexibility
• Optimize use of component life time
• Shorten outage duration

* Flex-Power Services is a registered trademark of Siemens AG, Germany.
We offer you a site specific analysis to determine the best timing to implement the most feasible technical measures from the Flex-Power Services portfolio at your power plant. Siemens Energy Service offers a full range of service capabilities to help you manage your maintenance and outage schedules.

References
Siemens Energy has successfully implemented Flex-Power Services measures and features in fossil power plants worldwide.

References include e.g.**
• More than 45 Wet Compression systems are installed on various frame types in operation worldwide.
• More than 120 units are in operation worldwide with the Turn Down upgrade and have logged more than 2,500,000 equivalent operating hours (EOH).
• Upgrades to reduce the cool down time have been implemented worldwide since market introduction.
• More than 34 units have been equipped with the operation mode Hot Start on the Fly for faster starts of the steam turbine.

Scope of supply
We provide our recommendations and engineering expertise based on your stated objectives.

Measures for providing Power on Demand and enhancing the start & stop performance can include:
• Wet Compression for gas turbines
• Rotor flexibility package for generators
• Hot Start on the Fly for steam turbines

Measures for enhancing Grid Services, like allocation of peak power and fast load gradients, can include:
• Grid code studies (e.g. ENTSO-E)
• Turn Up for gas turbines
• Fast Wet Compression for gas turbines

Measures for the reduction of the Minimum Part Load consider emission objectives and efficient plant operation and can involve, for example:
• Turn Down and Low Load Turn Down for gas turbines
• New high pressure barrel with an interstage valve for steam turbines

Measures for enhancing Maintenance Flexibility can include:
• Reduced cool down times for gas turbines, steam turbines and generators
• Extended scheduled inspection intervals for gas turbines
• Advanced component preservation concepts

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** as of August 2017
The Plant
The coal-fired Cottam power plant in Nottinghamshire, middle England, was built in 1969 and has been operated by London Energy (EDF Energy) since 1990. With a capacity of four 500 MW hard-coal-fired units, it supplies up to 4% of the UK’s electric power need.

The Task
As the UK government had significantly decreased the permissible emission values, output of NO\(_x\) at Cottam had to be reduced by at least 20%. Such a step usually involves high investment in plant equipment. EDF was committed to finding the most cost-effective way to meet the new requirement. The challenge was to reduce NO\(_x\) emissions in Cottam while simultaneously increasing plant efficiency and leveraging cost savings to improve their market position in a highly competitive environment.

The Solution
To meet the new requirements while avoiding extensive mechanical modifications of the plant equipment, EDF decided for optimization of the combustion process with the help of NO\(_x\) Reduction performance optimization solution, part of the Siemens Omnivise Digital Services portfolio.

The measurement system uses a series of laser beams which detect the distribution of temperature and the concentrations of CO, O\(_2\) and H\(_2\)O directly above the combustion zone in the furnace. The results are used for a two-dimensional distribution calculation which forms the basis for the optimization itself. Closed-loop set point corrections are calculated for existing combustion controls.

These corrections manage, among other things, the individual balancing of the air and fuel mixture for small groups of burners and where applicable – of over-fire air. In this way, the combustion process of the hard-coal-fired power station can run with higher efficiency, lower coal consumption and, of particular importance, with significantly reduced primary NO\(_x\) emissions.
Indeed, the 34% reduction in NO\textsubscript{x} exceeds the contractually guaranteed target performance value. The range of benefits offered by Siemens NO\textsubscript{x} Reduction performance optimization solutions, coupled with Siemens’ fast and competent project execution, simultaneously helped the operator to fulfill their commitment to meeting environmental requirements, improve efficiency and reduce costs.

**The Result**

- **Reduced NO\textsubscript{x} emissions and increased efficiency:** Optimization of the combustion process helped the operator to exceed governmental requirements and improve efficiency of the plant.

- **Reduced operating costs:** Lowered coal consumption and a more efficient burn cut operating costs.

“The fact that the trial led us to place further orders for two units tells its own story. In truth, we hadn’t expected to achieve quite the level of performance we’re getting.”

Wolfgang Hahn, Head of Design Authority, EDF Energy
Drax Power Ltd., UK
Combustion optimization for extremely heterogeneous fuels

The Plant
Drax Power Limited operates England’s biggest power plant, comprising six 660 MW units. As a contribution to climate-neutral power generation, almost three units have been upgraded to run on 100% sustainable biomass instead of coal. In 2014, Unit 3 was the first biomass system to be equipped with the NO\textsubscript{X} Reduction performance optimization solution, part of the Siemens Digital Services Omnivise suite of solutions.

The Task
For the last ten years Drax has been developing the capability to provide renewable electricity through upgrading almost half of the power station to run on biomass. In addition to reducing NO\textsubscript{X} emissions, Drax wanted to cut operating costs by using biomass more efficiently. Key requirements were the fast implementation of the solution, the integration of the measurement signals into the secondary deNO\textsubscript{X} process (SNCR) and guaranteed reduction targets for NO\textsubscript{X} and excess air.

The Solution
The NO\textsubscript{X} Reduction performance optimization solution enabled the targets to be met. The solution features a laser measurement system, which determines the temperature and flue gas composition directly in the combustion chamber.

The fuel composition, for example the sodium content, can also be determined. This detailed information on the combustion situation forms the basis for optimizing the combustion parameters in real time. The additional measurements of local O\textsubscript{2} and CO concentrations over and above the temperature distribution, are an important contribution to the improved use of the SNCR installations.

Combustion optimization is made possible by the individual adaptation of the existing air-fuel controlled variables, especially the air staging and excess air, in accordance with requirements. Classic, model-based control concepts are used here to ensure transparency and long-term maintainability by trained customer personnel.
With the help of Siemens NOx Reduction performance optimization solution, Drax was able to meet its contractual reduction targets while cutting its operating and investment costs.

The Result

- **Reduced NOx emissions and increased efficiency:** Optimization of the combustion process helped the operator to exceed governmental requirements and improve efficiency of the plant

- **Reduced operating costs:** Lowered coal consumption and a more efficient burn cut operating costs

- **Improved transparency and controllability:** Laser-based measurement of the combustion products directly in the combustion chamber

“At Drax we didn’t just want to upgrade our units to run on biomass, we wanted to optimize the combustion process as much as possible. The strong partnership between Drax and Siemens had a large role to play in our success in achieving this and we are both extremely proud of what we accomplished.”

Les Lemmon, Engineering Manager, Drax Power Limited