ABB’s Optimax® plant performance monitoring determines online characteristic parameters of the essential plant components and compares them with set points delivering key performance indicators. This condensed information enables a fast and precise overview of the plant and thereby improved plant operation.

Power plants include thousands of analog process measurements, hundreds of drives and thousands of positioners all working together producing exactly the required amount of electricity. In modern plants this job is done by 1-3 operators supported by a modern control system and by condensed information from plant performance monitoring.

Challenges
Power plant operators are in charge to keep up efficiency under continuously changing loads.
Power plant maintenance staff shall reduce both unplanned outages and maintenance costs.
Power plant managers strive for meaningful figures for strategic decisions.

Solution
Variables such as efficiency, heat rate, etc. are calculated cyclically or event-controlled with current or historical input values and compared to time-variant set points. The calculated performance values support the optimum setting and monitoring of the plant’s operation. They provide financial information on the energy performance of the power station unit. Monitored plant component efficiency combined with plant component run times enable condition based maintenance.

Plant performance monitoring contains ready-to-use modules for calculations according to DIN and ANSI/ASME PTC. Real-time and historian values are calculated in an easy and consistent way. Calculations keep track of compatibility of engineering units, sequence of evaluation steps and quality of process values. A graphical browser supports this with drag and drop facilities and easy tracking of bad values. Plant performance monitoring facilitates online and offline performance analysis of the process and runs cyclically or on demand.

Services
ABB takes over complete turnkey responsibility for engineering, installation, training, commissioning and support.
Integration
Plant performance monitoring usually runs in cyclic mode first checking for normal and steady-state condition of the process, secondly averaging input data over e.g. 5 minutes. Plant performance monitoring results are stored in the process data historian. Therefore, the results are useable as any other historian signal. The results can be presented on additional mimics on the operator environment. Furthermore, the results can be visualized with user defined trends or reports.

The plant performance monitoring application builder provides maximum flexibility in reconfiguring or dynamically modifying system parameters, even during system operation. Users can create, modify and delete calculations without disturbing or interrupting others already in progress.

Usability
A standardized library allows users to define their own performance calculations. On request ABB can expand the calculation module library at any time for special requirements. The calculations range from simple arithmetic calculations to more complex performance calculations according to international norms (ASME, DIN).

The inputs of the calculation modules can be connected with process data or constants. An automatic unit check and conversion executes within the calculations, ensuring that the process values will be converted, if necessary, to those dimensions which are expected by the calculation module.

Users can configure their calculations to run cyclically in automode, as a scheduled task, or they can run them interactively, e.g. entering input data through MS-Excel.

Users can easily configure the start time and trigger the recalculation sequence. The system will then read the historical input values and will recalculate all corresponding results. This is very useful, for example, in cases certain input values were found to be wrong or missing. This feature may also be used for retrofiling existing plants, by feeding the historical input values from the plant historian into plant performance monitoring, using the recalculation mode.

Key performance indicators
Actual plant/component performance is calculated at the current load, ambient conditions and operation mode using well tested modules, e.g.:
- Steam Generators (fossil-fired, SG)
- Heat Recovery Steam Generators (HRSG)
- Combustion stoichiometry for SG or HRSG
- Gas turbines
- Steam turbines
- Feedwater heaters
- Evaporators
- Superheaters
- Heat exchangers
- Desuperheaters
- Air preheaters
- Condensers
- Pumps, fans
- Generators
- Overall plant balance
- Auxiliary power and steam
- District heat
- Process steam
- Mathematical and statistical calculations
- Water/steam properties
- Gas properties

Expected plant/component performance is preferably calculated from characteristic curves based on heat balance sheets or generated from archived plant data representing the equipment in a “new & clean” condition, i.e. at the time of acceptance tests, or after a major revision. On request the expected values can be derived from design data or process models.

The ratio of actual and expected performance data is used as a key performance indicator to monitor short- and long-term equipment degradation. The key performance indicator has no dimension and should be close to the value of 1. Decreasing key performance indicator means decreasing component performance.

Controllable Losses
At times when the plant operation deviates from the design, additional energy losses occur. Controllable losses include measured process values that can be controlled by the plant operator and having a known impact on plant energy losses.

Controllable losses are e.g.:
- Condensate water temperature at feed water tank inlet
- Feed water temperature at boiler inlet
- Feed water temperature at economizer outlet
- live steam temperature
- live steam pressure
- reheated steam temperature
- reheated steam attemperator spray flow
- flue gas temperature at boiler exit
- O2 flue gas concentration at boiler exit
- electrical auxiliary power
- condenser pressure
- makeup water flow
- boiler drum blow down water flow
- gas turbine inlet air temperature (if cooling is available)
- air preheater leakage (flue gas O2 up and downstream)

An operator process mimic presents the following for each controllable loss:
- actual measurement value
- design value (=expected value)
- impact on plant efficiency / heat rate
- additional plant fuel consumption due to actual deviation from design value

What-if
E.g. the performance engineer replaces controllable losses actual measurement values by manually defined “what-if” values. The calculation shows the impact of all deviations of controllable losses from their design values.

Benefits of Plant Performance Monitoring
- For operators
  - Performance information for the entire plant and for its components is collected, displayed, and calculated on an automatic, periodic or on demand basis.
  - Key performance indicators are displayed on-line and make operators aware of equipment running with decreased efficiency.
  - Controllable losses show the cost impact of operation away from design point.
  - What-if calculations reveal the cost benefit of improved controllable losses.
- For maintenance
  - Early detection of wear and damage reduces unnecessary time based inspections and improves availability and efficiency.
- For management
  - Established performance calculations document efficiency know-how.
  - Trends and reports document efficient plant operation.
  - Real-time records of deviations from normal operating parameters help to establish, diagnose and predict performance trends.

References
- Amer 8 CHP, Netherlands
  - coal fired, 645 MWel, 250 MWth
- Rostock STPP, Germany
  - coal fired, 950 MWel
- Maasvlakte 3, Netherlands
  - coal fired, 1100 MWel