# PowerOPTI

## Coal Power Plant Thermal Performance Monitoring & Optimization System (M&O)

*Power plant continuously generates a huge amount of process data. The important objective is their validation, correct interpretation and utilization for control, diagnostics and optimization purposes.*

### OBJECTIVE

**Enhancement of power output**, performance supervision and equipment health diagnostics.

### FUNCTIONS

- **Early warning of hidden faults and performance degradation**, long trend evaluation of critical equipment performance – boiler, turbine, condenser, heat exchanger, cooling tower
- **Unit power output uprate** by cooling water flow rate optimization
- **Lost megawatt hunting**

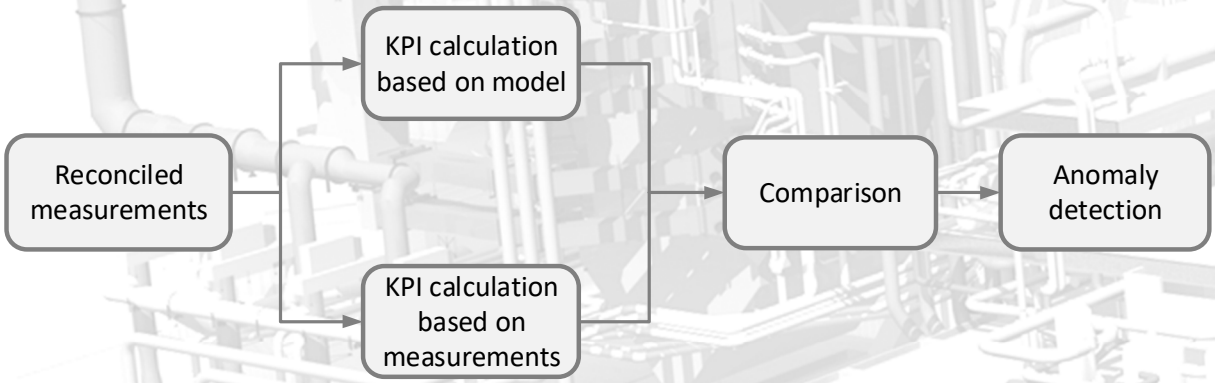
### KEY COMPONENTS

(1) On-line robust measured data validation and reconciliation by mathematical model based on mass and energy balances:

- Detection, identification and elimination of gross errors in measurements
- Accuracy of measurement improvement
- Reliable calculation of unmeasured variables and **KPI** (**key performance parameter of equipment / process**); boiler efficiency, turbine efficiency, cooling water flow rate, etc.

(2) **On-line equipment health diagnostics and thermal cycle optimization** by **high accurate empirical models** (digital twins). Comparison between actual and expected states in given operating conditions:

- Boiler, turbine
- Condenser, heat exchanger
- Cooling tower, cooling circuit



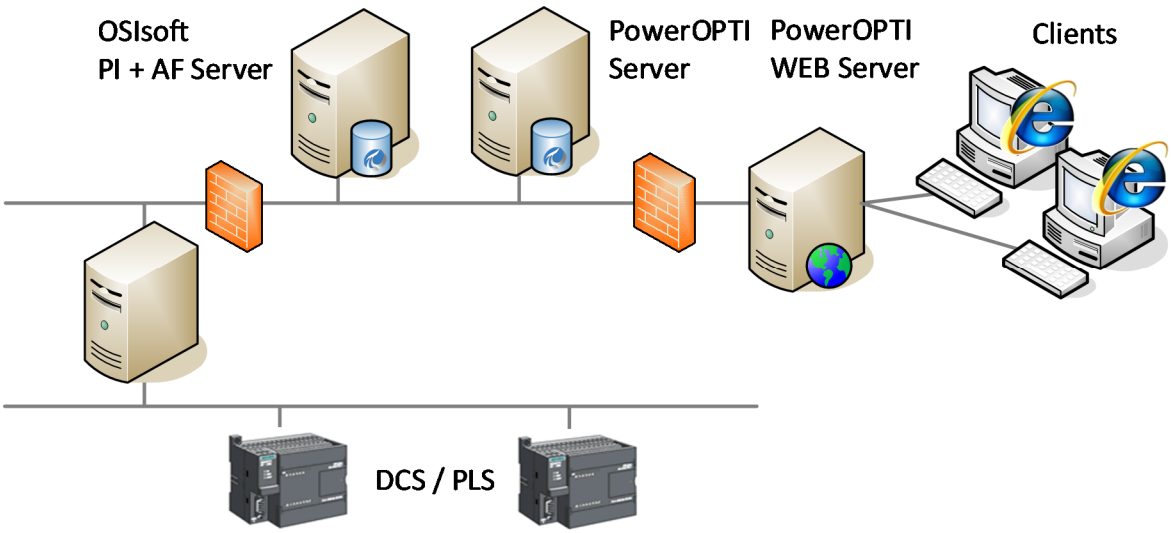

**Empirical model accuracy vs. output power loss; fault detection ability = power loss prevention**

| Equipment | Fault detection starting | Reliable fault detection | Output power loss |
|---|---|---|---|
| Boiler | ↑ 2,0 MWt | ↑ 4,0 MWt | = loss detection |
| Turbine | ↑ 1,0 MWe | ↑ 2,0 MWe | = loss detection |
| Condenser | ↑ 0,1 kPa | ↑ 0,2 kPa | ↑ 0,5 kPa → 5 MW loss / 1000 MW turbine |
| Cooling tower | ↑ 0,2 °C | ↑ 0, 4 °C | ↑ 1, 0 °C → 3 MW loss / 1000 MW turbine |

## BENEFITS

| (1) Better accuracy, better confidence in data |
|---|
| • Detection, identification and elimination of measurement errors<br>• Measurement accuracy improvements; reconciled values satisfy mass and energy balances |
| **(2) Deep view inside the processes and equipment health** |
| • Unmeasured quantities and KPI calculation<br>• Unusual states detection and to this time unused information exploitation |
| **(3) Equipment supervision & diagnostics** |
| • On-line equipment health evaluation, early fault detection<br>• Process performance supervision, lost MW hunting, predictive maintenance support |
| **(4) Process optimization & prediction** |
| • 1 to 2 MW power output uprate for 1000 MW unit<br>• Accurate power output planning |

**M&O structure example using OSIsoft components**




## DEPLOYMENT ACTIVITIES

- Data validation and reconciliation; gross errors detection, identification and elimination
- Diagnostics model building; equipment fault detection, evaluation of degradation trends
- Trail operation; loss MW hunting
- Cold end turbine optimization; power output uprate

## BUSINESS CASE EXAMPLE: POWER PLANT (2 000 MWe) 2015 – 2017

| | |
|---|---|
| Cooling water flow rate optimization; turbine power output – CW pump power input | 2,0 MW power uprate<br>350 000 EUR/1 year income increasing |
| Early condenser fault detection | 1,5 MW output power decreasing elimination<br>120 000 EUR/3 month loss elimination |
| Fouling evaluation of cooling tower fills | 3,5 MW output power decreasing elimination<br>550 000 EUR /1 year loss elimination |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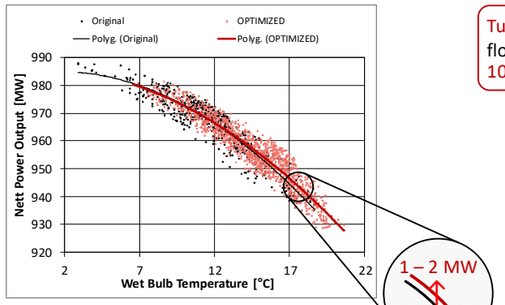
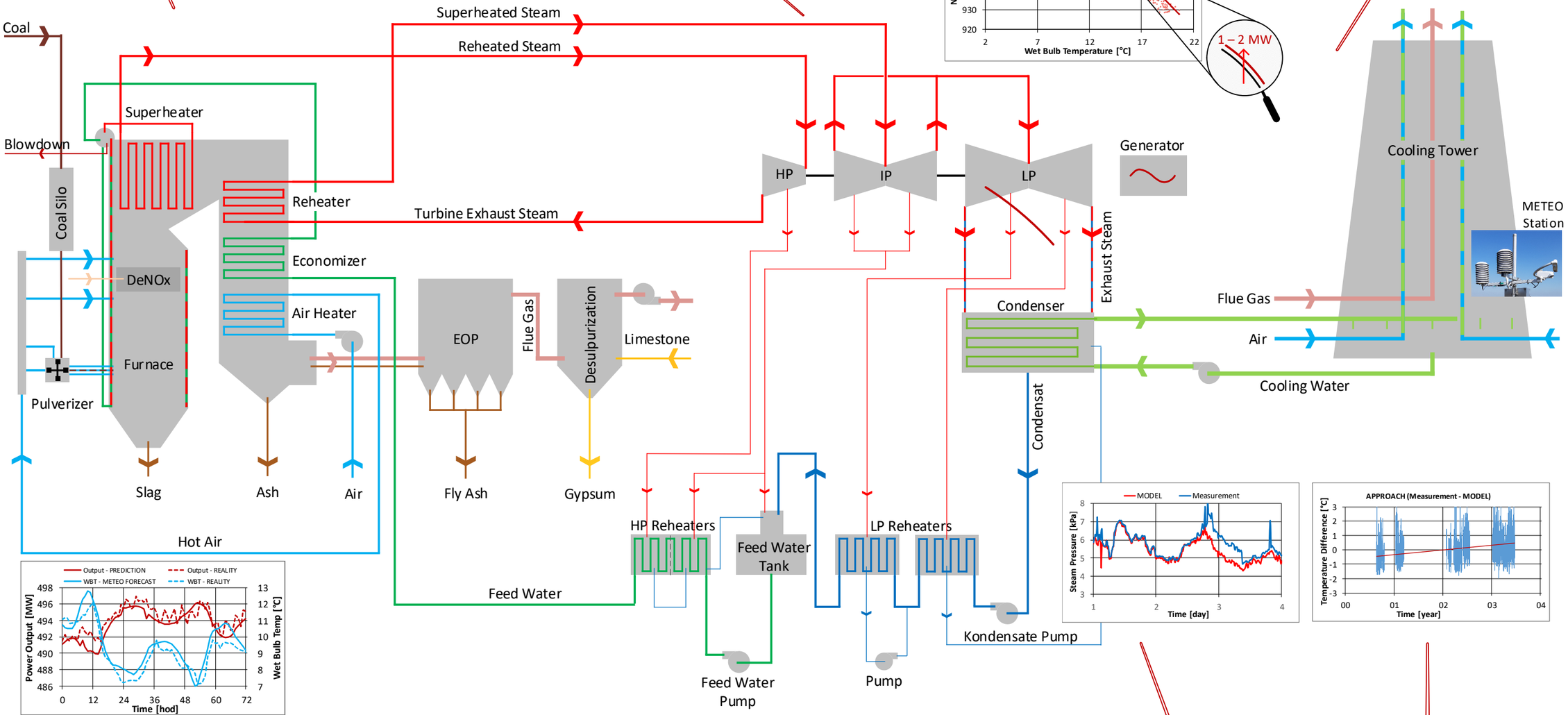
On-line Boiler Diagnostics
- Early alarms, after service testing
- Leakage, exchanger fouling, ...
- Unmeasured quantities and KPIs calculation
Accuracy 4,0 MWt (2,0 MWt)

On-line Turbine Diagnostics
- Early alarms, after service testing
- Leakage, exchanger fouling, ...
- Unmeasured quantities and KPIs calculation
Accuracy 2,0 MW (1,0 MW)




Turbine cold end Optimization / Cooling water flow rate optimization
1000 MW unit power uprate ↑ 1 MW (2 MW)







On-line Unit Supervizion & Diagnostics
- Power output accurate prediction
- Loss MW hunting
- Thermal efficiency enhancement
Accuracy for 1000 MW unit 2,0 (1,0) MW




On-line Condenser Diagnostics
- Early alarms
- Air in-leakage, fouling
Accuracy 0,2 kPa (0,1 kPa)




Off-line Cooling Tower Diagnostics
- Fill fouling and damaging
- Maintenance planning
Accuracy 0,4 °C (0,2 °C)