



Eskom Emission Monitoring

Eskom conforms to legal emission limits with help from Wonderware



About Eskom Holdings Limited

Eskom Generates approximately 95% of the electricity used in South Africa and approximately 45% of the electricity used in Africa. The company generates, transmits and distributes electricity to industrial, mining, commercial, agricultural and residential customers and redistributors. The majority of states are in South Africa. Other countries of southern Africa account for a small percentage of sales.

Additional power stations and major power lines are being built to meet rising electricity demand in South Africa.

Eskom buys electricity from and sells electricity to the country of the Southern African Development Community (SADC). The future involvement in African markets outside South Africa (that is the SADC countries connected to the South African grid and the rest of Africa) is currently limited to those projects that have a direct impact on ensuring a secure supply of electricity for South Africa.

The Current Eskom Power Generation Fleet: (One Unit = One boiler + one generator)

The measurement of stack emissions at coal-fired power stations is of high importance to Eskom as exceeding the emission limits may result in the forced shutdown of generating units. These emission levels are imposed by legislation and must therefore be monitored and alarmed continuously.

To address the problem, system integrator Bytes Systems Integration used Wonderware solutions to implement a comprehensive emission monitoring system which is flexible enough to handle geographically-dispersed data sources while complying to various business rules. The result is a system which is helping to ensure the supply of electricity while minimising the impact on the environment.

Background

The combustion of coal produces almost as much carbon emissions as the combustion of petroleum (figure 1). What can we do about the more than two gigatons of carbon released into the atmosphere in the form of carbon dioxide every year? The answer is; "not much" unless you treat the problem at its source – which is exactly what Eskom has been doing for several decades. 95% of Eskom's generating capacity comes from coal, and ash emissions from Eskom's coal-fired

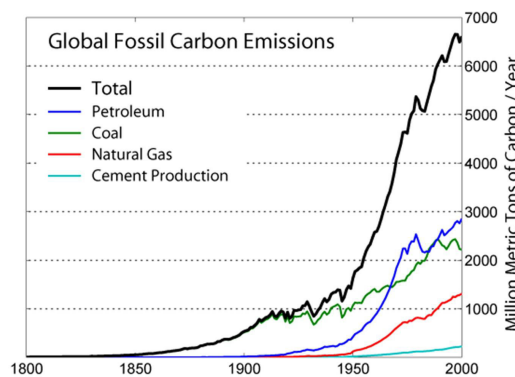


Figure 1: The main contributors to global fossil carbon emissions

Type of Generation	Power Stations	Number of Units	Total Capacity (MW)
Coal fired power stations	13	93	37410
Open cycle gas turbine	4	20	2414
Hydro	2	6	600
Pump Storage	2	6	1400
Nuclear	1	2	1930
Total Installed	22	127	43754

power stations have reduced by more than 90% since the early 1980s due to the installation of efficient pollution abatement technology and the decommissioning of older plant.

“Without treatment, we would be spewing concentrations of 30 000 to 60 000 mg of ash/normal cubic metre into the atmosphere,” says Dr. Kristy Ross, senior consultant at Eskom. “But with the use of abatement technology such as electrostatic precipitators or fabric filter plants, more than 99% of ash is removed from flue gas stream providing a particulate emission concentration of usually less than 200 mg/normal cubic metre.”

Getting legal

Every power station has an emissions licence with which it needs to comply. This ensures that the environment and health of people in the vicinity of power stations are not affected negatively. The emissions licence specifies two limits – a ‘normal’ operating limit, which emissions must be below for 96% of the time and a ‘cap’ limit, which emissions must never exceed. For example, Lethabo Power Station’s licence limits are:

- Normal limit: 75 mg/Nm³
- Cap limit: 300 mg/Nm³
- Grace period: 90 hours per stack (three units). Time given to rectify malfunctions such as poor quality coal, equipment breakdown, etc. The normal limit can be exceeded for this time, but emissions must remain below the cap limit.

Staying within these legal requirements, however, isn’t plain sailing. Because of the capacity shortage, shutdowns for maintenance or repair are reduced to a minimum which means that equipment isn’t necessarily operating at maximum efficiency. Varying coal qualities and high load factors also contribute to the difficulty of complying with the legal emission limits.

Under exceptional circumstances, where taking a unit off load would result in load-shedding, we ask the authorities for short-term exemption from the emission licence rules, usually from the normal limit,” says Dr. Ross.

“This project proves once again that the Wonderware System Platform can be used to add tremendous value to any organisations. The flexibility of System Platform enabled us to connect to multiple source systems and applications to deliver critical decision-making information to the highest levels of the company.”
Gerhard Greeff, Bytes Process Management and Control

The problem

Control room operators at power stations must keep a constant lookout for potential emission problems that might exceed the set legal limits. In the case of such an event, it might be necessary to exercise what’s known as “load loss” but this will have a ripple effect in that another power station will be required to take up the slack by ramping up its production.

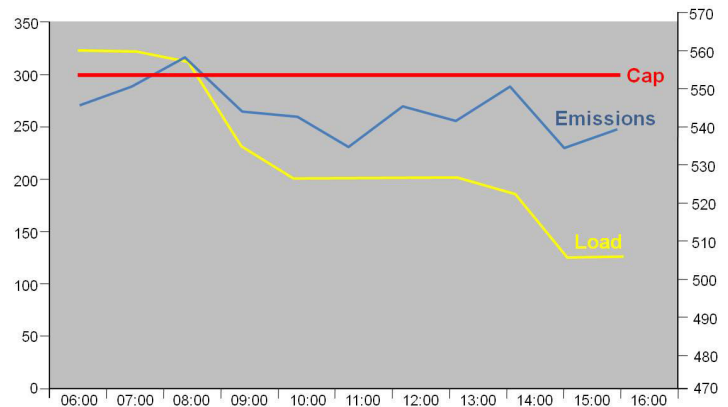


Figure 2: Cause and effect—High load demand resulted in emissions exceeding the cap limit which initiated “load loss” which, in turn, brought emissions to within the legal limits.

The solution

“Given the scope of the problem and Eskom’s nation-wide footprint of 13 operational coal-fired power stations, it was decided that emission status should be centrally monitored and controlled in real-time from the Integrated Generation Control Centre at Megawatt Park,” adds Dr. Ross.

This would allow the information to be available remotely through a user-friendly interface so that environmental specialists could take the necessary action to control some complex processes. Top executives also needed access to this information via a web-interface.

In short, the project goals were to:

- Prevent financial and production losses caused by forced outages.
- Prevent environmental degradation and fines from authorities due to exceeded emission limits.
- Deliver real-time KPI dashboards and reports.
- Give early warning alarms before emission limits are exceeded, enabling preventative measures to be implemented.

Solution selection

System Platform (ArchestrA)-certified system integrator Bytes Systems Integration was chosen for the project because of the company's long-standing and successful relationship with Eskom, notably in the Enterprise Manufacturing Intelligence (EMI) field of which this project forms part.

Due to its ease of integration with other initiatives and customisation capabilities as well as its scalability, Bytes would use the existing Wonderware infrastructure consisting of System Platform (ArchestrA), Historian, Historian Client (ActiveFactory), InTouch (SCADA/HMI), Information Server and Alarm Provider.

Implementation

Figure 3 shows the interaction necessary between all the players. Aggregated hourly averages from each power station is sent to Megawatt Park who can make the necessary operational decisions.

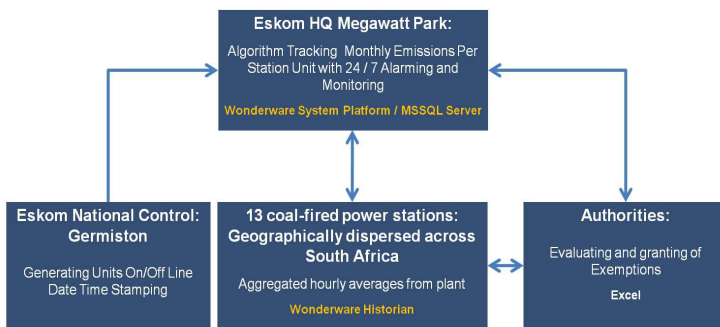


Figure 3: System flow diagram (Eskom WAN)

Machiel Engelbrecht of Bytes explains: "For example, during start-up after shutdown, a unit's emissions will be higher than during normal operation. So it's important to know when a unit is about to come on line, how long it was off and how long the higher emission level is likely to last. This helps apply for the necessary exemption from the authorities. In addition, the supplied information places Megawatt Park in a good position to initiate preventative measures and to ensure optimal load distribution in the event of a shutdown due to excessive emissions."

The geographically-dispersed historians are used as the base for real-time information and this is then compared to targets, plans and projections from other transactional systems such as information supplied by National Control (Simmerpan - Germiston).

Trending information is required to monitor the emission levels over certain time periods and this is done with ActiveFactory. Aspects of the Wonderware Historian Client are also used to calculate the hourly time-weighted averages.

Wonderware's Information Server is used to distribute data and information where it can be monitored from any client workstation.

A single dashboard for each thermal power station was developed showing hourly emission values together with their specific limits and for how long the normal limit was exceeded. Additionally any applicable exemptions to the limits are also shown and the system adapts automatically. Early warnings are raised when the emission values get within 20% of the acceptable limits where the right decision can be made to prevent penalties and unit shutdowns. A simplified robot on the dashboard gives a quick overview of the stations' status from where the user can drill down to more detailed information.

The first three Power Stations' emission monitoring was delivered within a month. This was followed by training of head office's control centre operators, environmental consultants, managers and station personnel.

Bytes enlisted the help of environmental specialists from Eskom to provide scenarios and business rules. They also interacted with various system owners within the organisation for access to data. All the development and tests were done on a live system. "The end-user was helpful by entering manual data such as exemption information, in parallel to their existing process," says Engelbrecht. "This speeded up delivery as all values could be verified in real time. Excel was used as an input form for the operators at the stations as it is a product with which they are familiar. We used MSSQL to extract the time-weighted hourly averages from the Wonderware Historian."

The main beneficiaries of the system's information are senior consultants from Environmental Management who generate reports for the authorities. Other beneficiaries include top executives and head office Generation Control Centre personnel, especially those involved with the early warning system which involves risk and strategic analysis.

The system is integrated with the legal documentation of the authorities and client. It is also integrated with a number of other transactional and web-based systems within the business infrastructure.



Figure 4: Desktop “widgets” alert supervisors of critical conditions and help them drill down to the cause through easy-to-understand dashboards.

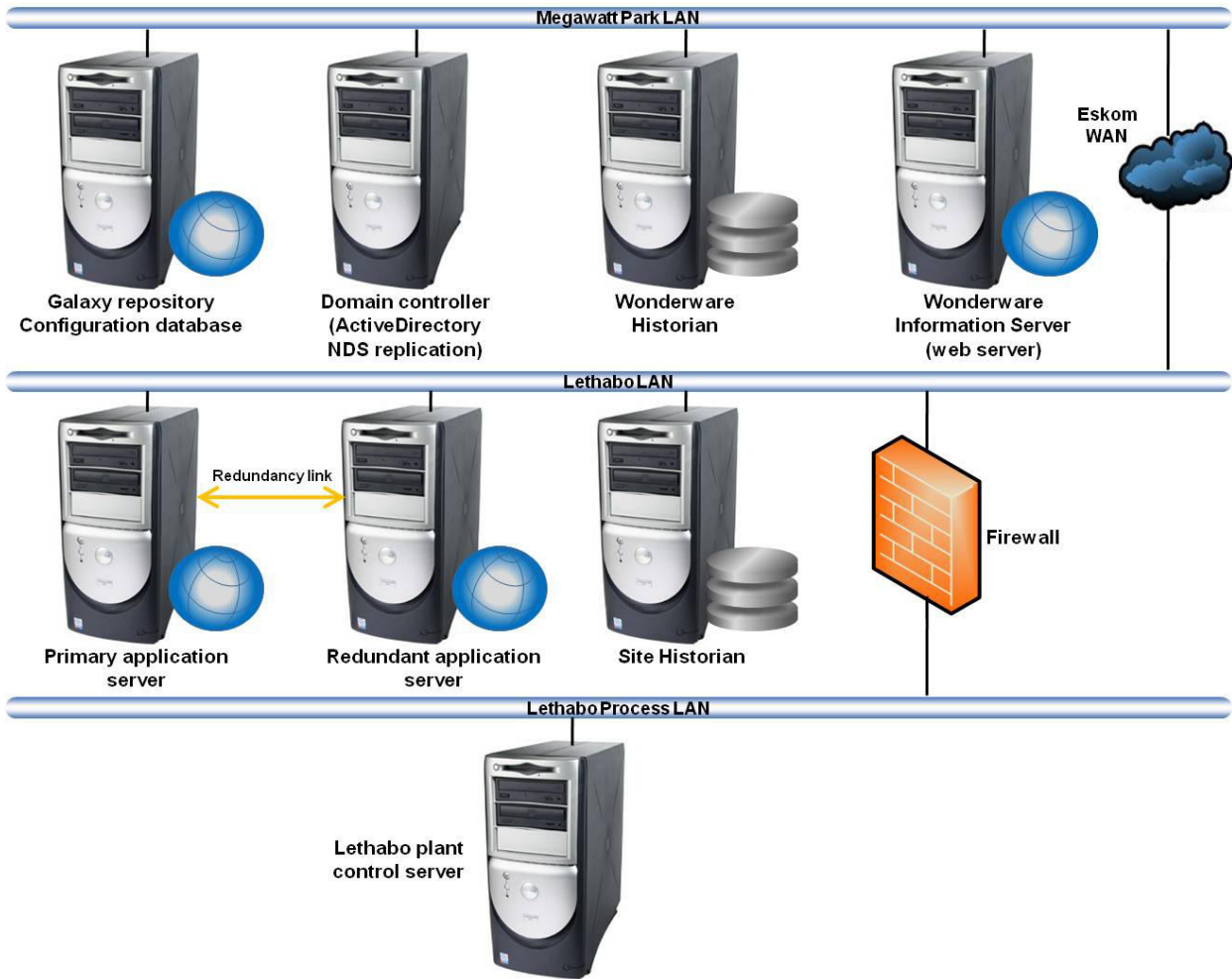


Figure 5: System topology for each coal-fired power station (only Lethabo shown)

"I cannot believe how quickly this system was implemented."

Dr Kristy Ross, Senior Consultant, Eskom

Benefits

- Weekly reports are now supplemented with hourly monitoring – no more "after the fact" initiatives
- Early warnings of possible forced load losses – allows for pro-active decision-making
- Real-time KPI dashboards and reports – presents a window on reality rather than history
- 24 Hour monitoring and alarming – follows the business Eskom is in
- Enables preventative measures to be implemented – early detection of trends is crucial to minimising downtimes
- Ensures compliance with emissions licence – elimination of environmental degradation and fines as far as possible
- Real-time monitoring of plant performance – provides symptoms of potential problems before they affect service delivery

"Due to the integration, scalability and versatility of the various Wonderware solutions used, it was possible to deliver a sophisticated system quickly for a process which was previously accomplished manually due to its complexity."

Machiel Engelbrecht, Bytes Systems Integration

Conclusion

Eskom's vast resources literally run South Africa. Many people do not fully understand the consequences of not having them. Quite simply, Eskom is responsible for the way we run our lives and it is encouraging to see the steps the company is taking to ensure the continuity of that way of life.

So, the next time you experience a blackout, it may not be due to insufficient generating capacity but to ... ash.

Thankfully, that particular source of annoyance is being minimised rapidly through Eskom's proactive initiatives.

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