Energimagasinet 4/2010
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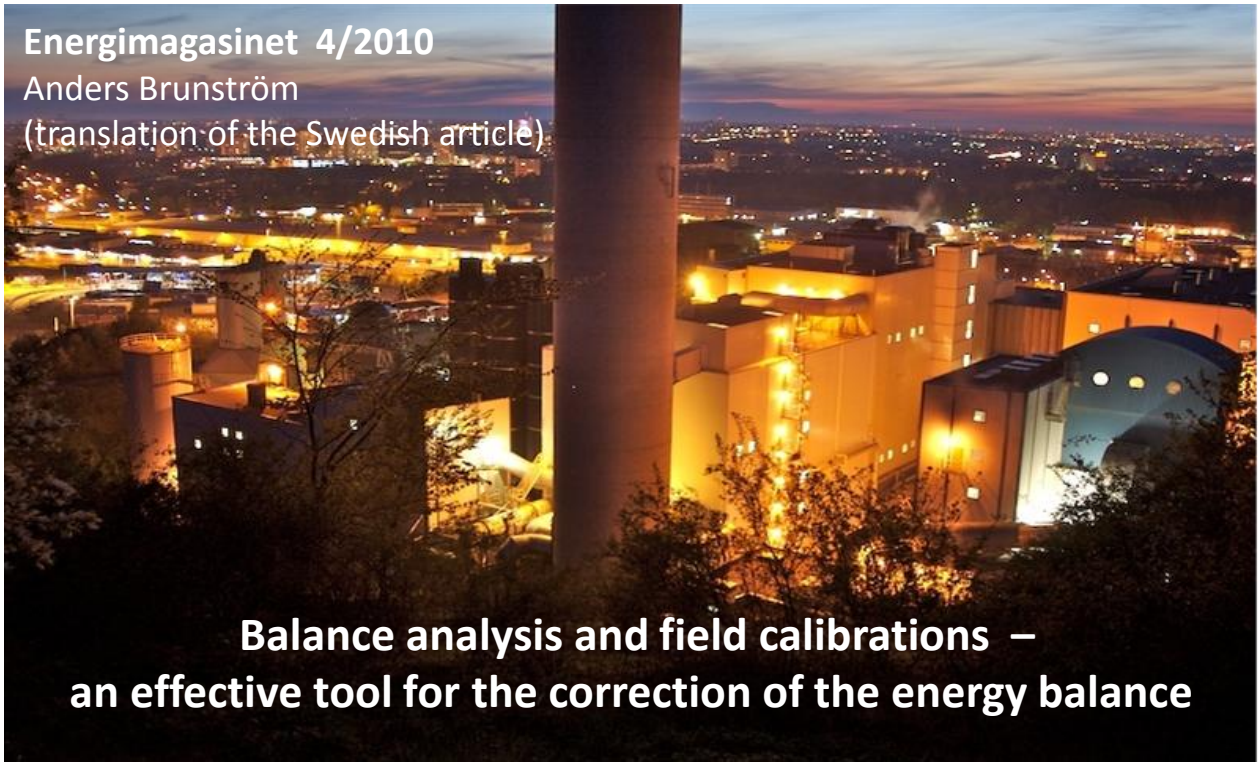
(translation of the Swedish article)



Balance analysis and field calibrations – an effective tool for the correction of the energy balance

A large persistent measurement difference up to 30 MW between the produced and delivered energy was observed at Fortum Högdalenverket. To correct the energy balance the measurement positions with significant measurement errors were first identified by using the balance analysis and then calibrated on-site.

Fortum Högdalenverket

Högdalenverket, established in 1970, is a large waste incineration plant used in the Stockholm area. Unsorted municipal and industrial waste is incinerated and transformed to electricity and district heating energy at the plant. Today Högdalenverket consists of 6 boilers and 2 generators and has the maximum production capacity 337 MW.

The challenges of the energy balance of Högdalenverket

The energy production and delivery of the plant are measured and controlled by hundreds of process measurements for flow, temperature and pressure. The plant is a quite complicated production unit due to its growth history and has had many increases of the incineration capacity and renovations of the existing production equipment.

Partnering with Indmeas

The plant has a long cooperation history with the Finnish measurement company Indmeas Oy. Indmeas Oy has carried out periodical on-site calibrations for the plant´s most important flow and energy measurements.

With the last renovation project, there was a large difference between the produced and delivered energy. In certain production situations, the difference exceeded 30 MW. This clearly indicated that, in spite of the on-site calibration program, there are large unknown measurement errors in the energy balance. Due to the differences, the management could not trust the monthly production reports and optimize accurately the operation of the plant. According to Anders Eklund, technical manager for production and distribution, the differences caused further difficulties in the estimation and budgeting of fuel consumption.

To correct the balance, Högdalenverket had initially two alternative solutions competing with the one proposed by Indmeas. The first one was the simulation of the whole process by using a comprehensive computer program. The weak point in this method was the fact that the simulation was to be based on the existing process measurements that were proved to be mostly unreliable. The second alternative was to increase measurement redundancy by installing more energy measurements in the process.

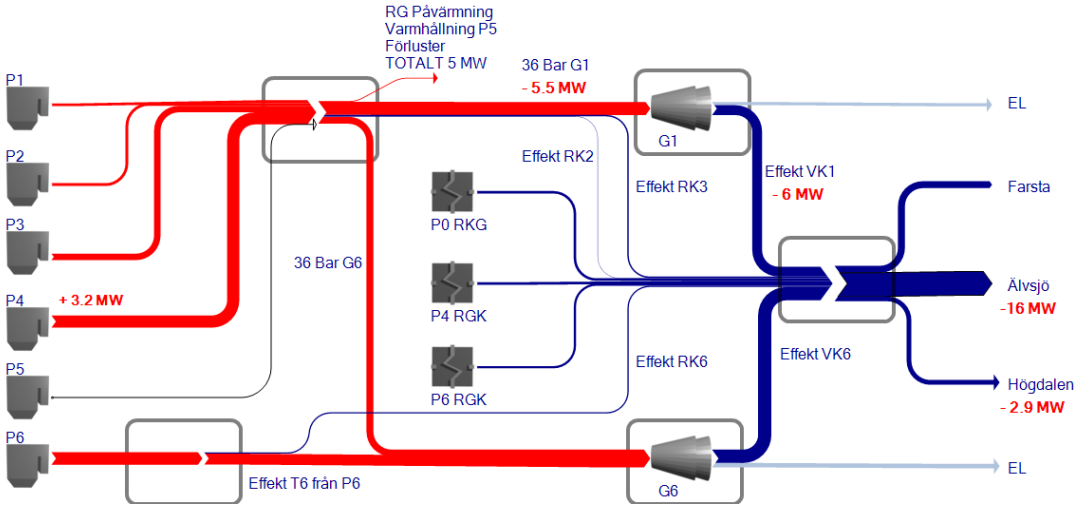
By comparing the redundant measurements, conclusions on probable measurement errors would be made. This approach was evaluated to be too slow and too inaccurate in this fairly complicated case. Högdalenverket evaluated Indmeas´ solution proposal, i.e. on-site calibrations steered by balance analysis, to be the most efficient and cost effective approach. Therefore, Högdalenverket chose Indmeas to be the cooperation partner in solving the problem.

Correction of the energy balance

The calibration of all measurements of the large energy balance would have been, in practice, almost impossible to do. It is, however, quite reasonable to assume that there are only a fairly limited amount of measurement positions with significant measurement errors. If using the ability to steer the calibrations to these positions first, there would be an essential improvement in the efficiency of the correction work. The balance analysis provides a tool for this purpose.

The balance analysis is a statistical analysis method that uses the large measurement history data available in the plant´s automation system. It applies the energy and mass conservation laws to the measurement network of the balance and determines probable measurement errors for all measurement positions. The error estimates are not highly accurate but accurate enough to steer the accurate calibrations with good probability to the positions with significant measurement errors.

The first balance analysis for Högdalenverket, done in autumn of 2008, revealed the main measurement errors of the balance. The most significant measurement error was found in the flow measurement of a delivery district heating line that had not been included in the earlier calibration program. The analysis revealed, also, several errors in energy calculations.



The Sankey diagram of Högdalenverket indicating the principal balance points and the estimated largest measurement errors.

The corrections in the energy calculations and the recommended calibrations were done in the following winter and spring. The second energy balance analysis carried out in the summer of 2009 proved that the corrections had decreased the difference from the earlier 30 MW to 5 MW. The second balance analysis showed smaller errors in the inner positions of the balance and one unstable flow meter. The simple simulation calculation proved that the correction of these would reduce the difference from 5 MW to close to zero.

The evaluation of the method

The method, i.e. the combined use of balance analysis and on-site calibrations, was apparently very efficient in the correction of the energy balance of Högdalenverket. In fact, the method can be seen as a major improvement step in the industrial measurement quality assurance. Besides solving the acute problem at Högdalenverket, the method brought along several other benefits:

1. The quality control was extended from the positions included in the earlier calibration program to cover all measurements within the energy balance of the plant.
2. The measurement results were validated up to the monthly energy reports prepared for the plant management .
3. After the balance analysis has once been done, its repetition is easy. Thus, it provides an economical means for detailed continuous or semi-continuous control of the measurement quality of the balance.
4. Repeated balance analysis can be used to improve the efficiency of instrument maintenance work.

As Anders Regert, the group leader of the instrument maintenance group of Högdalenverket, states:

"The balance analysis will help us to move from calendar based instrument maintenance to on-demand based instrument maintenance."