Real-time energy performance management of industrial plants using Industrial^{IT}

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Lower energy consumption, cheaper energy, less downtime, higher product quality, better asset utilization, improved safety… industry's wish list is long. Yet it is also realistic. ABB developed its Industrial^{IT} information architecture so that performance criteria like these can be managed efficiently, in real time. And it can be implemented step by step, as ambition and insight grow, with just a minimum of engineering effort.

Industry runs on energy. Every industrial process depends on it. Across all industries, on average, energy consumption accounts for around 5% of the value of shipments. In some process industries this figure can rise to as much as 70 or even 80%. But it's not only cost that's important: the amount of energy used also has an impact on the environment. On top of all this, there is the quality and reliability of the power supply to consider, since these can affect product quality, output, asset utilization and safety. Most of these factors will, at some time or other, influence every branch of industry, but, inevitably, any one industry will want to focus on those specific to its own energy management needs (see panel) [2, 3].

In spite of increasing recognition of the need for energy management, manufacturing industries typically focus on production throughput and quality. The result of this is that there is little awareness and knowledge of the key contributors to energy loss, preventing any kind of improvement in real time. Also, the deployed tools and systems tend to be scattered around the plant, with users focusing on only part of the picture. Multiple data sources add to the misery. It's hardly surprising, then, to learn that management of energy-related data is often inefficient and inconsistent.

Energy management, like any improvement program, relies on collecting data, identifying opportunities, setting targets,

Industry's 'to do' list

Industry's drive for more efficient energy management is concentrated in three main areas [1].

Reduce energy consumption

- Review maintenance and operating procedures.
- Modify existing equipment and processes (eg, by retrofitting). Alternatively, modifications can be incorporated in new designs.
- Utilize assets more efficiently after carefully examining production processes, schedules and operating practices.

Reduce cost of energy or increase selling price

- Plan and schedule production according to time-dependent tariffs; shift consumption to low-cost time slots; sell own surplus generation capacity at high cost.
- Monitor energy use; verify utility bills.
- Schedule production to avoid power peaks that may violate utility contracted limits. Monitor tie lines; shed loads.

Increase availability and quality of service

- Schedule production to avoid power peaks that may violate equipment capacity limits. Monitor capacity limits; shed loads if needed.
- Monitor quality of utility service.
- Automatic switching of capacitors.
- Automatic start-up of standby generators.

implementing changes and monitoring results. Efficient access to the *right information* is key.

Although different information is required for different tasks and for different users, most of it can be derived from core energy data, eg consumption, losses, efficiency and availability 1. What is usually missing is a means of efficiently organizing and aggregating the energy-related data. Consistent information should be presented to the plant operators in real time, when required in views designed for specific users, to support their improvement decisions. ABB's Industrial^{IT} solutions were developed to do this, and much more.

The importance of 'context'

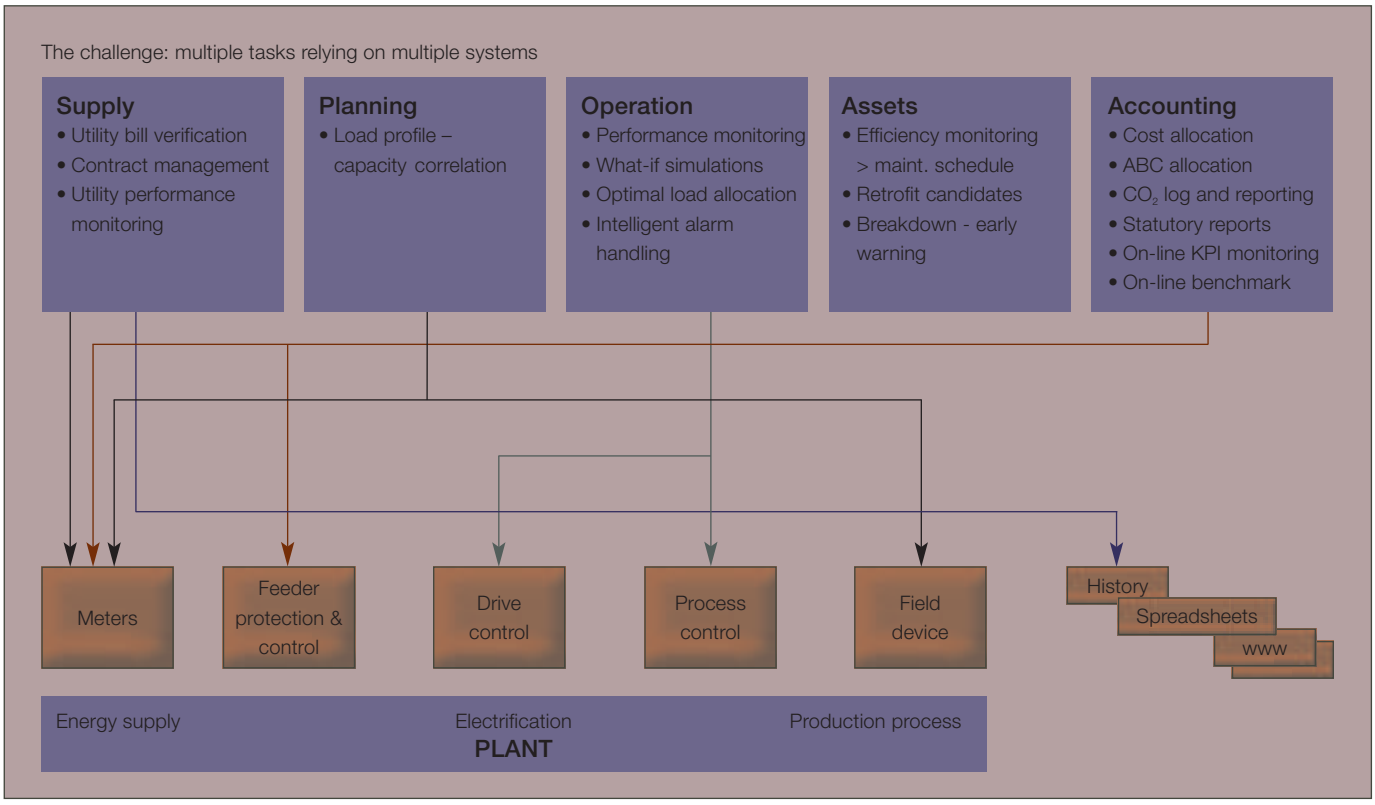
Having determined that every user involved in energy management should be provided with the right information at the right time, the next issue has to be 'Which data?' Large quantities of data are normally available, but often they are of little benefit to the user for one simple reason: they cannot easily and efficiently be put into the proper context. This is a major omission, since organizing and putting data to good use benefits users more than simply adding more specialized functionality to the existing portfolio of energy management software.

When the performance data are provided in context, improvement targets can be defined and monitored. It is also important that the tools and methods used support step-wise improvements and changes.

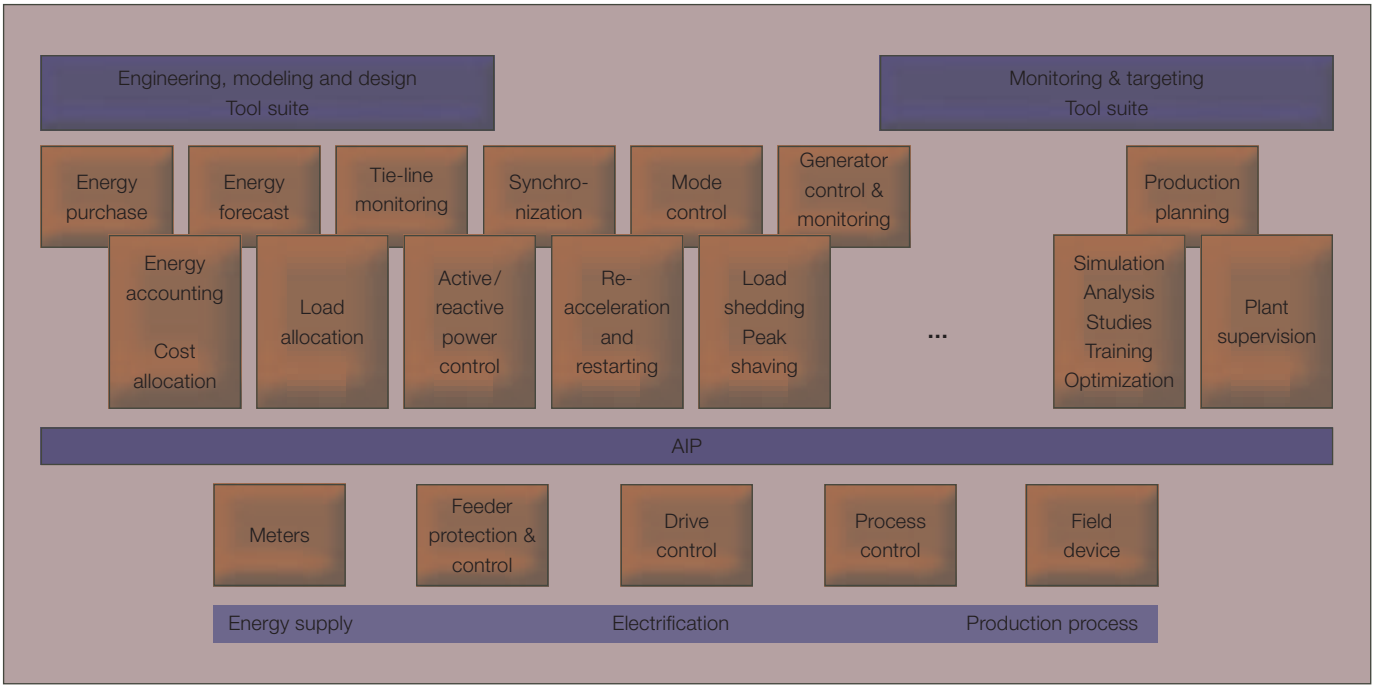
Goodbye to the 'forklift' approach

2 shows the range and diversity of the functions and systems involved in energy management in industry. As is seen, the number and complexity of the systems, databases, process models and applica-

1 In an industrial plant, energy-related information is required from a wide range of systems for many different purposes.

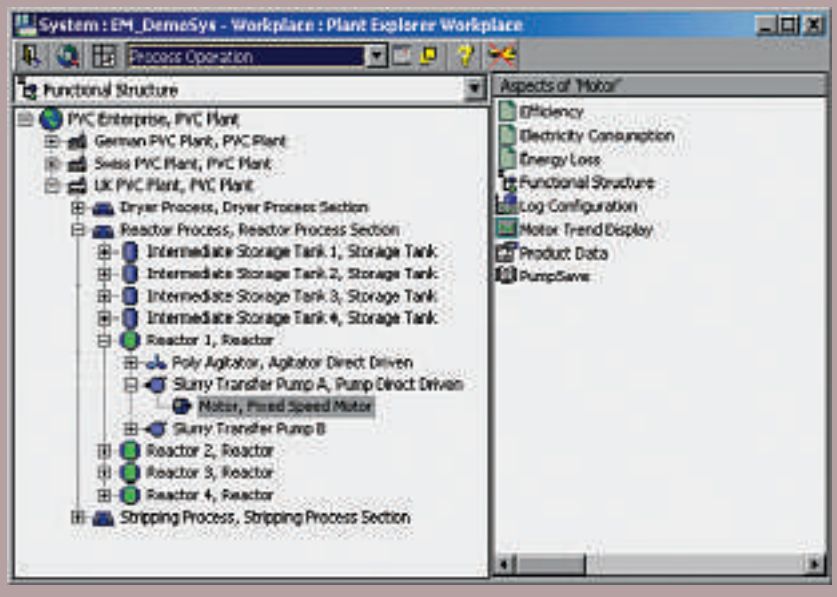


2	Typical scope of functions and systems required for energy management. ABB's Aspect Integration Platform (AIP) facilitates their integration, allowing data sharing, one-time entry of information for multiple applications and easy navigation.



tions that are used can be considerable. Given such complexity, the 'forklift' approach – in which all the existing software applications are replaced by new ones – is hardly feasible. Luckily for industry, it is also no longer necessary. With the help of ABB's Aspect Object™ technology and its software architecture, the Aspect Integrator Platform (AIP), all the systems can be made to communicate with each other – providing users with consistent, timely and relevant information, configured exactly as required.

3	Plant components are organized hierarchically as 'Objects'. Each Object has 'Aspects' associated with it. Energy-related Aspects of the Object 'Motor', for example, are efficiency, electricity consumption and energy loss.



To understand better how ABB's Industrial IT architecture works, it is useful to consider its implementation in an actual industrial plant. But before we do, let's look at how Industrial IT organizes information, and at the terminology used to describe it.

Industrial IT – the technology

Information and functionality are structured in Industrial IT by organizing plant components, referred to as 'Objects', into structures, and relating real-time information and/or functionality, or 'Aspects', to them. The Aspect Objects™ can be defined at various plant levels, which could be a motor, a reactor, even an entire plant.

By structuring Aspect Objects in this way, Industrial IT provides a powerful tool for searching and summarizing information. And it gives information about the functional breakdown of the plant.

Information can be accessed with the desired level of detail; for example, the user may wish to know the energy consumption of the whole plant, of a specific process section, or of a component.

The different items of energy information are related to the Aspect Objects using designated Energy Aspects. These Aspects provide uniform access to the different items of energy information. For example, users access the energy consumption of a single pump in exactly the same way they would access the energy consumption of a whole plant 3.

> More than 65 % of all industrial electrical energy is consumed by motors. Using ABB analysis and improvement software, energy information can be efficiently exploited in this area.

The Efficiency Aspect is calculated using input from other Aspects, such as electricity consumption and product data, as a basis. The calculation model is preset once for all motors. Once the structure is set, Aspects can be aggregated at any desired level with just a few mouse clicks 4, 5.

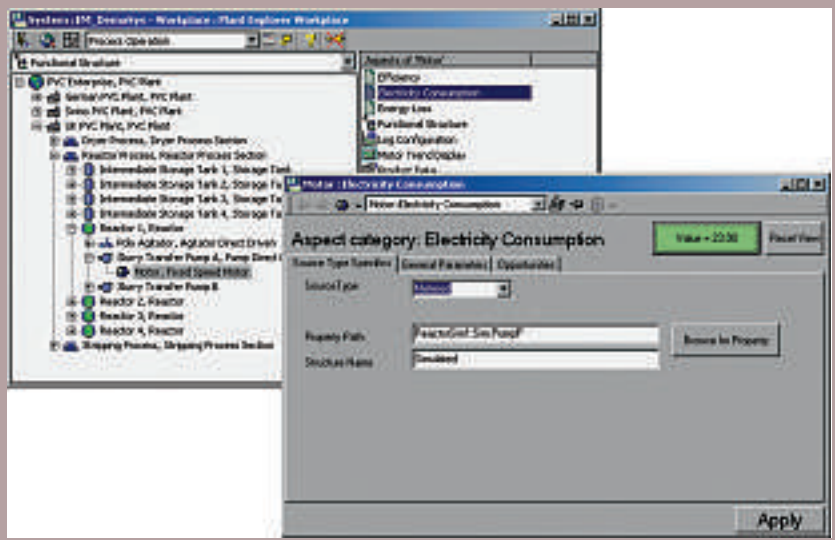
The 'process to boardroom' perspective

Now let's assume that the CEO of, say, a PVC plant has just left the boardroom and is wondering how he will deliver the 10% annual reduction in energy use that he has just promised, let alone systematically track and report actual consumption. And do it all without diverting his scarce human resources from their main job of getting the product out on time and exactly according to the specification.

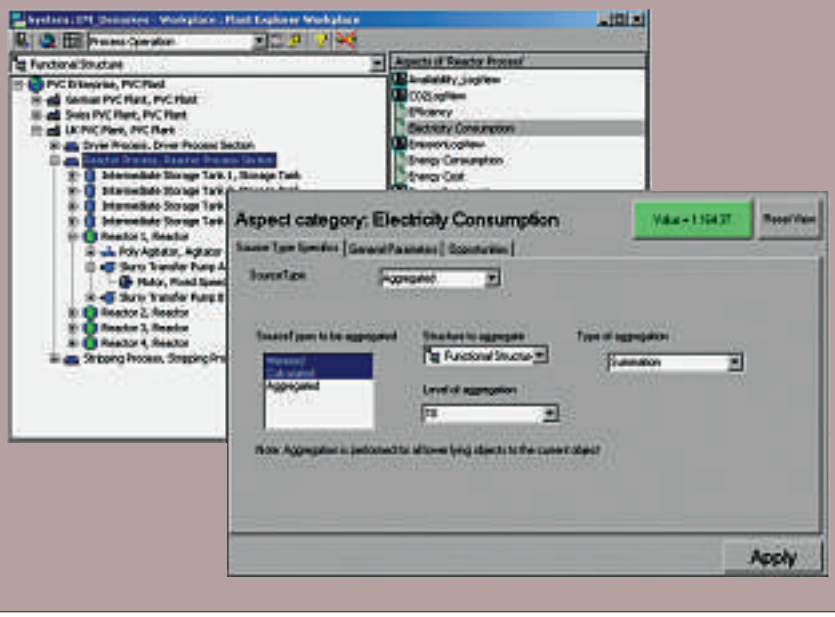
With Industrial IT, his organization will not have to spend additional resources to *monitor* energy performance; it is automated and consistent, with alarms and events that can be assigned to alert personnel should production be off target. In addition, he can search for *improvement potential*, or use benchmarks to compare units within his plant, or compare his own plant with world-class performers.

The CEO can drive *accountability* by assigning targets and actual results according to responsibilities. Energy data is automatically and consistently aggregated in the appropriate line of command.

4	Aspect information is easily configured. The information may be meter readings, calculations or come from aggregated sources on a given path..



5	Energy-related information can be aggregated from energy Aspects of plant components at any plant level in real time. Here, the electricity consumption of the reactor process section is aggregated from the consumption of Objects at lower levels.



Information that needs to be read and entered manually, estimated, or is only available with limited resolution, should not be neglected either. Starting with whatever is available, sophistication – data and optimizers – can be added, step-by-step, down the line.

Industrial IT offers a true 'process to boardroom' perspective; one that enforces strict organization of data whilst enabling flexible monitoring and retrieval of information, for predefined use as well as for ad-hoc purposes. And, once implemented, it drives improvements, raises performance awareness and assigns accountability.

From key performance indicators to improvement opportunities

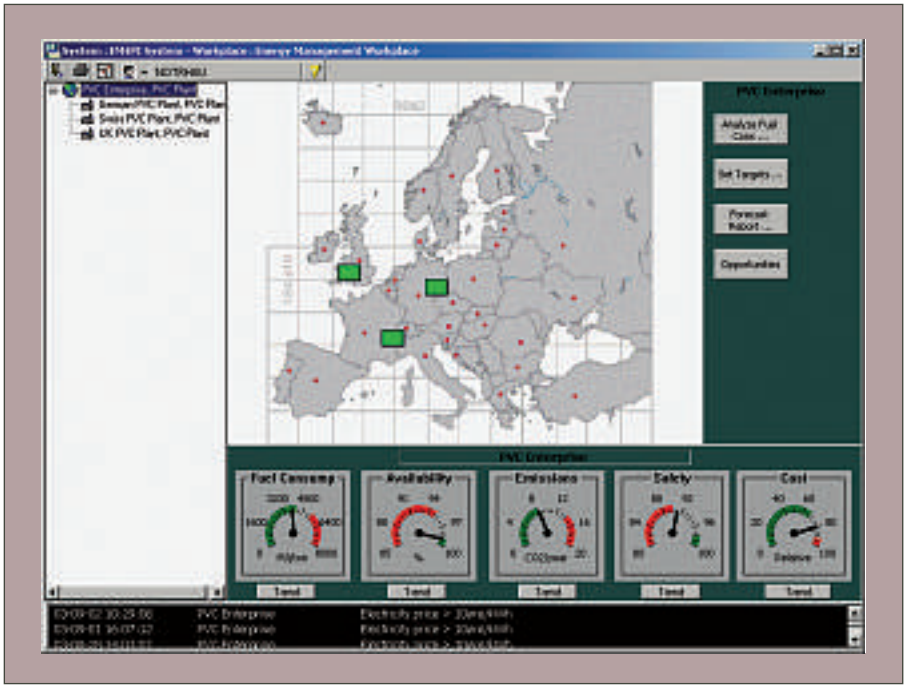
For our CEO to meet his commitment to reduce energy consumption, he and his staff need a whole range of information, and especially the key performance indicators that will show them how they are progressing. A collection of these indicators can be seen on the sustainability dashboard in 6. The dashboard is also a starting point for navigation, providing the user with a first view of the 'drill down' capabilities that will let him explore details and improvement opportunities.

To identify improvement opportunities, the user first investigates the KPI specifics and searches for improvement potential based on actual performance data. Industrial IT assists with decision-making by drawing the user's attention to 'hot spots', such as compressors, pumps or heaters, whose operating ranges or scheduling can be changed to make them more efficient. The operational history and statistics are also provided, along with equipment ratings for a more detailed analysis. The user can even search the entire plant for the components or processes that contribute most to energy loss 7. Information from other Aspects can be searched and analyzed in a similar way.

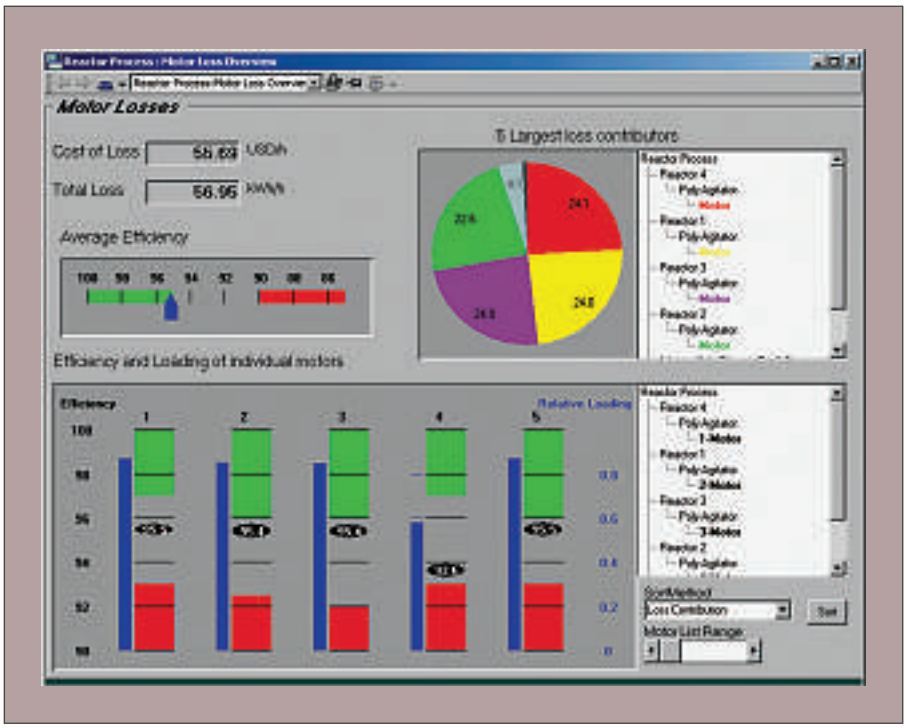
Improvement software

More than 65% of all industrial electrical energy is consumed by electric motors, making them easily *the* target when talk

6	The sustainability dashboard shows the user actual performance indicators and targets – in this case at the enterprise level, with drill-down opportunities.



7	Objects throughout a plant can be searched. Here, the user has found the 5 main contributors to loss in a PVC production facility.



turns to saving energy or reducing environmental impact. ABB offers a range of analysis and improvement software with which energy information can be efficiently exploited for the more efficient use of electric motors.

Three stand-alone tools are available to help plant owners with decision-making:

- The *drive efficiency* tool calculates the efficiency of an existing AC drive system and compares it with that of a new, more modern system.
- *FanSave* and *PumpSave* tools calculate the saving and payback time for the replacement of an older flow control method by AC drive control. (8 shows the PumpSave tool integrated with the AIP.)

8 Analysis of motor efficiency based on real operational history and motor and load ratings. The tool suggests potential financial and environmental benefits of replacement.

The Aspect Integration Platform enables the drive and motor software to be run continuously, and also retrofit analyses and financial impact calculations to be run using real plant data. An efficient roll-out is facilitated, with relevant tools made available to all motor Aspect Objects, irrespective of the load Aspect Objects.

ABB's Aspect Integration Platform enables drive and motor software to be run continuously and retrofit analyses and financial impact calculations to be run using real plant data.

Of course, it is not usual to check the motor efficiency, loading, environmental impact, and so on, every day. However, a typical large plant has hundreds of motors, and while their individual consumption might not be significant, the aggregated consumption might well be.

The benefits that come from combining Industrial IT-based energy management with the right tools come to the fore when shutdowns are planned. Then it can be used for a plant-wide motor analysis, or to draft a list of retrofit candidates based on the required payback period. And that's not all! The financial and physical impact of energy-saving and environmental improvements can be aggregated, as can the cost of the respective investments.

For additional improvements, other ABB or third-party software products and tools can be integrated, allowing dedicated and maximum use of the energy data made available by Industrial IT and Energy Aspects.

The performance manager

Industrial IT, by enabling plant-wide data to be efficiently organized, supports the acquisition, analysis and aggregation of energy-related information, as well as the integration of improvement software. And there is no need to invest the considerable effort in engineering and configuration that is required, for example, when traditional historian-based solutions are used.

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References

[1] IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE STD 739 – 1995

[2] **C. Resnick:** Energy management and optimization systems providing documented savings and ROI. ARC Insights no. 2001-047M, ARCweb.com, Oct. 2002.

[3] **D. Forsyth, B. Ahmad:** Importance of energy management systems in the deregulated power market. EXFOR 2003, 89th Annual Meeting of the Pulp and Paper Technical Association of Canada, Montreal.

[4] Manage your energy resources and reduce costs. ipw Internationale Papierwirtschaft International Paperworld 4.2001, 23–26.