Energy Management Information Systems Evolve To See The Bigger Picture
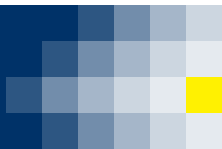
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KEY TAKEAWAYS

✓ Overly simplistic energy performance indicators (EnPIs) often drive energy savings—but at the expense of product yield or quality.

✓ A well-designed energy management information system (EMIS) can minimize energy cost without impacting production or could even enhance process performance.

✓ At a typical refinery, cutting just 3% in energy cost could save between $6 million and $9 million per year. Top performers have saved $20 - $30 million.

✓ Similar percentage reductions for CO_2 emissions are also achievable.

✓ Updating a standard open-loop EMIS to one with closed-loop optimization capabilities can produce dramatic improvements.

✓ KBC's Co-Pilot service could provide additional expertise and insight to further improve operations.

Part 1 Overview

Adding process considerations improves energy savings and production performance, and cloud-based support ensures benefits are sustained. Poorly designed and overly simplistic energy performance indicators (EnPIs) often drive energy savings at the expense of product yield or quality. However, a well-designed energy management information system (EMIS) can minimize energy cost without impacting production and, in some cases, can even enhance process performance.

Traditional energy monitoring applications mainly focus on improving energy-side key performance indicators for fired boiler and heater efficiencies, energy intensity, utilities' marginal cost, etc. These monitoring applications rely on inputs from various process measurement instruments, with temperature leading the way, to verify performance.

However, covering an expanded range of production parameters — including energy supply, demand and recovery, product quality and process yields — requires integration of the process with energy simulation, monitoring and optimization tools. This viewpoint shows how to overcome traditional barriers to energy saving by using rigorous process simulations to monitor performance and determine optimum operating targets for improving both energy and process performance.

The Energy Opportunity

In most process plants, energy is the largest controllable operating cost. A typical refinery or petrochemical plant could spend $200–300 million per year on energy. Cutting just 3% in energy cost could save $6–9 million per year. Such energy savings always result in direct bottom-line benefits. This is unlike adding capacity or changing product mix, which depend on anticipated market conditions.

Energy production and distribution systems often constrain processes. For example, a process compressor could be limited by the capacity and efficiency of its turbine drive. In turn, steam and condenser operating conditions or degradation of the turbine can mean the drive reaches its limit before the compressor does. In another example, the amount of heat a process furnace is able to deliver can restrict unit throughput. Energy-related bottlenecks often curb throughput of high-margin processes by 2–3%.

One challenge is understanding the amount of potential energy improvement. Plant operations typically compare themselves against their peers. However, this comparison is only meaningful if the leading facilities are highly efficient.

An alternative approach is to compare energy use against a thermodynamically and economically achievable minimum. Our company has developed an energy metric called the Best Technology (BT) index. The target BT index calculation is based on an optimized process configuration including reactor conditions, number of distillation column trays, etc., as well as a pinch analysis for heat recovery and R-curve analysis for utility delivery. This enables the specification of all equipment for maximum efficiency.

Pinch analysis is a methodology for reducing energy consumption of processes by calculating thermodynamically feasible energy targets. R-curve analysis determines the hypothetical ideal utility system and fuel utilization for power and steam generation.

$6-9
### MILLION PER YEAR
can be saved by cutting energy cost by just 3%.

Repeating these optimization calculations for a range of feedstocks, operating severities and product yields determines a relationship between optimum energy use and process performance. The optimum target energy benchmark is defined as 100.

The actual BT index is calculated as the ratio of actual energy use divided by the target, in percent. For example, if the plant is using twice as much energy as the benchmark, its BT index is 200%. Essentially, this index compares current energy use against that of the best available technology on the market.

Top performers have saved

$20-30

MILLION PER YEAR
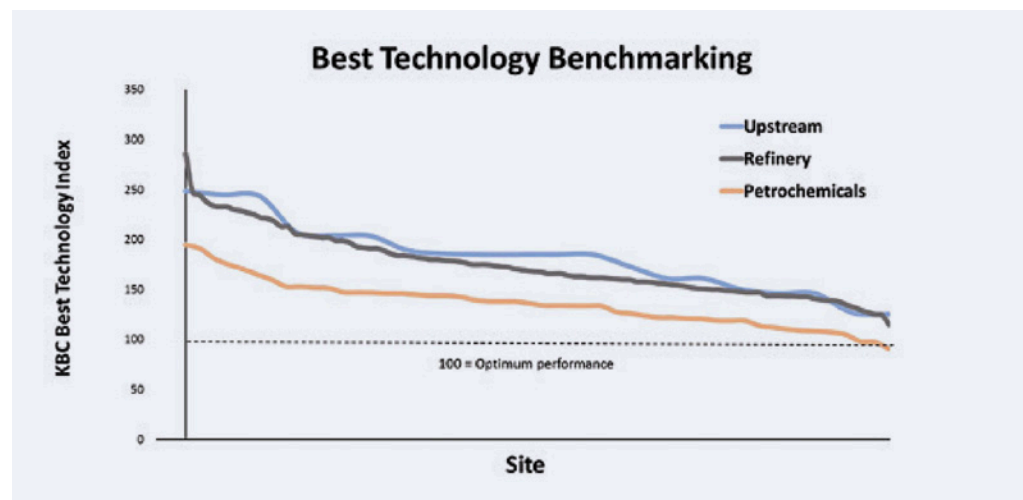
Figure 1 - Best technology benchmarking - most sites, even those that are relatively efficient, do not perform close to the optimum performance benchmark.

Even relatively efficient plants typically use significantly more energy than the BT benchmark. Figure 1 shows a trend of the BT index for several hundred sites arranged in descending order along the x axis. In the refining and upstream industries, even the best performers (right-hand end of the scale) have a BT index well above 100%. There have been many instances of top performers saving 10–15% of energy, worth $20–30 million per year. Similar percentage reductions for CO_2 emissions are also achievable.

Part 3   EMIS Issues

> " Many companies still use a traditional EMIS approach. This produces energy cost savings, but can miss some opportunities by failing to consider the combined effects of energy use and process performance.

Since most EMIS software packages focus only on the energy supply side (for example, the efficiency of production of steam and power for use in the process), their EnPIs do not reflect the impact of feedstock effects or process yield. For example, if energy consumption increases, they cannot indicate whether this stems from inefficiency, lower quality feedstock or the demands of higher quality products. While these software packages monitor equipment performance, they often miss the opportunity to switch an item of equipment off when it is not needed to support production.

EMIS software can become out of date and could be misused or plant personnel could fail to exploit its full value. Consequently, sites do not always act upon advice and recommendations provided by the EMIS because it is considered irrelevant.

An EMIS frequently does not address the interaction of energy and production yield. Since many plants highly integrate their energy systems with production processes, changes in one area have significant impact in others.

Complicating the problem are changes in staffing, particularly the loss of veteran staff and the push to adopt leaner operations. Those make it more difficult for work processes and practices to catch up with technology.

Nevertheless, many companies still use a traditional EMIS approach. This produces energy cost savings, but can miss some opportunities by failing to consider the combined effects of energy use and process performance.
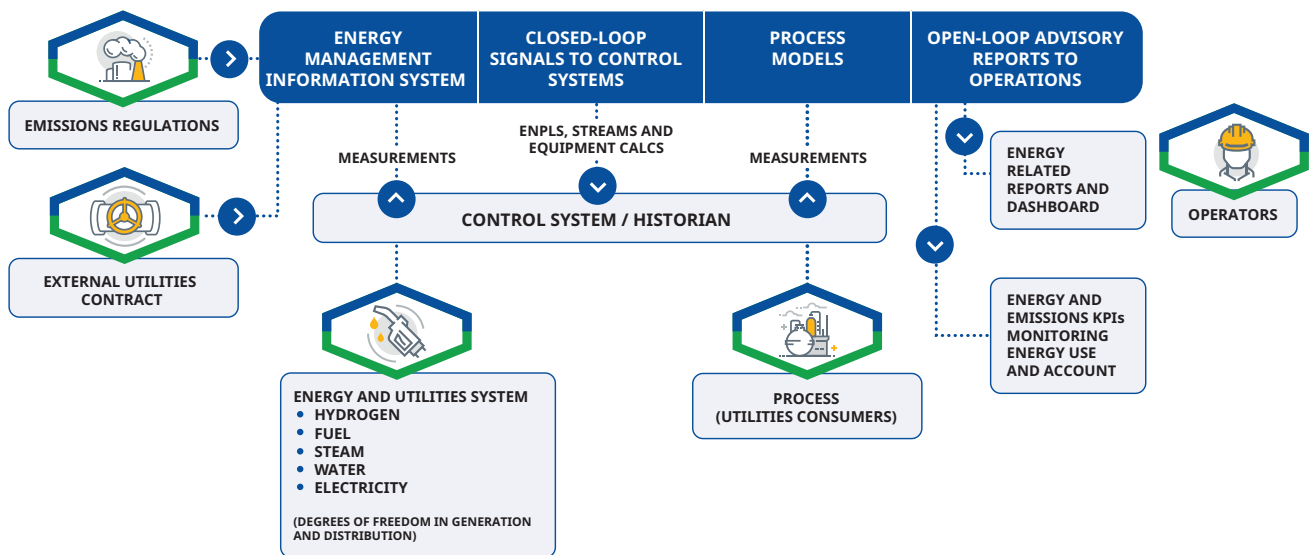
Figure 2 - Improved EMIS - data from the control system and historian enable experts to make recommendations for saving energy and improving process yield.

Part 4   An Improved Approach

Adding process considerations can solve EMIS problems. For instance, simplified EnPIs drove the wrong behavior in a fluidized catalytic cracker (FCC) at a refinery. In this FCC, there was an opportunity to reduce cooling water temperature by resolving an issue in the cooling towers. Colder cooling water would improve condenser vacuum and increase the efficiency of a condensing turbine, providing benefits in one of two ways:

1. Reducing steam demand and saving energy; or
2. Debottlenecking the compressor being driven by the condenser.

Conventional EMIS calculations for Option 1 show a small saving of steam, amounting to $80,000 per year, by improving the standard EnPI metrics of total energy use and specific energy consumption.

For Option 2, the EnPIs of total energy use and specific energy consumption are driven mainly by higher coke burn and increase. However, when corrected for the improved process performance, the BT index decreases. Profitability is dramatically better, with more than $10 million per year in increased value. The BT index is aligned with the yield drivers and, therefore, will not penalize profit optimization.

In this example, a single simulation platform with an integrated process and energy model performed the optimization to generate operating targets by considering both energy and yield. The resulting targets were embedded in the EMIS optimizer software.

Such an EMIS integrates energy production and supply with process modeling and optimization (Figure 2).

In closed-loop mode, the EMIS sends recommendations directly to the control system to adjust the energy system or process. It also produces energy-related reports and actionable recommendations for operators—a form of open-loop control.

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Part 5 Success Stories

Updating a standard open-loop EMIS to one with closed-loop optimization capabilities can produce dramatic improvements. For example, Air Liquide achieved impressive results at its Bayport, Texas, site. That facility produces oxygen, nitrogen and hydrogen, and supplies customers along the Texas and Louisiana Gulf Coast via an extensive pipeline network. It is Air Liquide's largest industrial gas complex in the world.

After using an open-loop EMIS, including its optimization capabilities, for several years, the plant decided to implement a closed-loop EMIS to cover the steam system, cogeneration and boilers — plus the extraction/ condensing turbines. The new EMIS allowed Bayport to operate in an optimum manner throughout the day, despite price variations in electricity supply every 15 minutes.

Closing the loop was like having the plant's best engineer on duty 24/7/365 acting as an energy watchdog. It produced the lowest energy cost within process constraints against a moving target created by the need to meet customer product requirements and changing energy prices. In addition, the implementation of each closed-loop variable incorporated reliability assurance.

A European refinery also achieved substantial benefits. KBC worked with the plant to implement a phased approach to energy improvements. The first phase involved a profit improvement program focused on opportunities to increase yield and reduce energy. By using specialized software to analyze energy consumption and make changes via the control system, the plant cut energy consumption by 2.7% across the site (Figure 3).

At the same time, KBC and the plant jointly participated in a strategic review to identify specific energy efficiency improvement projects. Implementing these projects over a two-year period reduced energy use by 11.9%. Then, addition of steam optimizer software enabled the plant to drive energy consumption down another 4%.

Energy Consumption During Project Lifetime
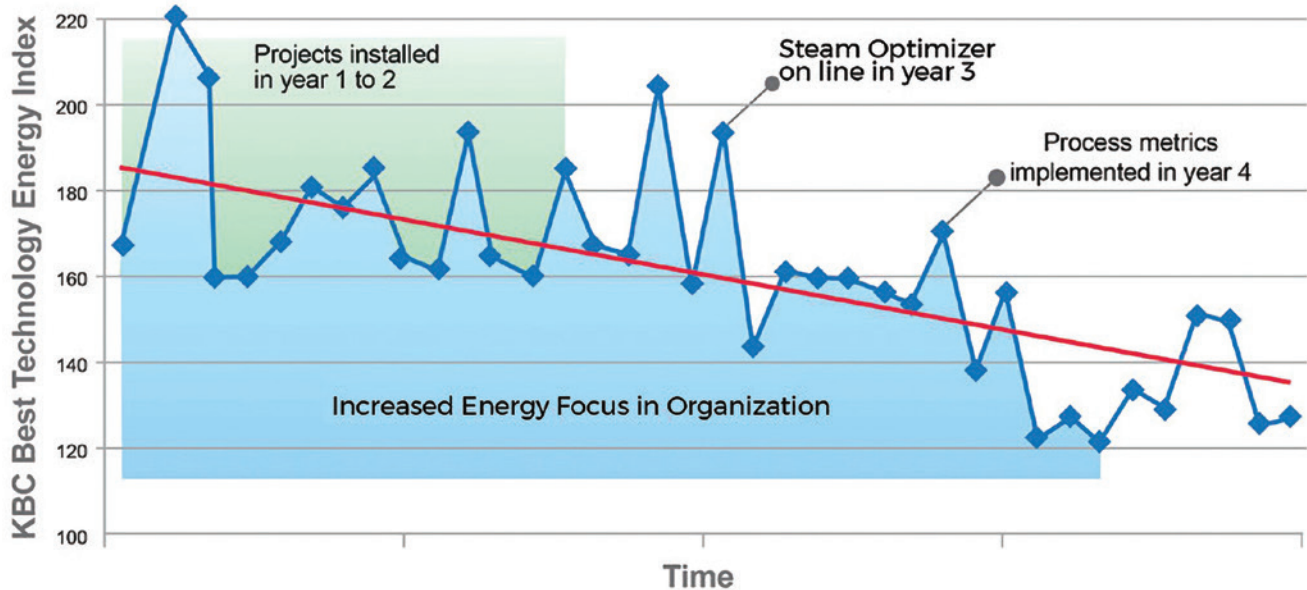
Figure 3 - A coordinated program between a European Refinery and KBC, covering all aspects of energy management, resulted in an overall energy saving of 20%.

A four year program reduced energy costs by

20%

Finally, the team developed energy metrics to monitor performance of the entire plant, saving an additional 1% in energy costs. Overall, the four-year program reduced energy costs at the refinery by 20%.

As these examples show, an on-site EMIS with optimization modeling software certainly can help cut energy costs. However, local staffing problems (i.e. fewer and less-experienced personnel) common at many facilities can undermine its value. No one might understand what the software is trying to tell plant personnel.

These types of situations can be addressed using the power of the cloud to allow collaboration beyond traditional boundaries of time and location. Data and recommendations of the local EMIS are fed to the cloud, enabling experts at the EMIS supplier to guide process plant personnel in taking appropriate action.

For example, KBC's Visual MESA energy management system and Petro-SIM modeling software, along with the control system's process historian, can all feed data to the cloud. Then, KBC's Co-Pilot service allows our experts to access and analyze the data to make recommendations and reports — providing the plant with the expertise and insight needed to improve operations.

Part 6 Update Your EMIS

Today, plants face a compelling need to reduce energy costs and improve yields without extensive and expensive equipment modifications — while ensuring energy enhancements do not adversely affect process performance but, ideally, improve it.

Improvements needed in EMIS software to address these issues include:

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- Process simulation to monitor performance and determine optimum operating targets by considering both energy and process performance
- Updated EnPIs with well-defined targets to track energy performance in a consistent way while minimizing feedstock and yield effects
- Site-wide energy management and optimization of utilities to deliver results and recommendations to the right people at the right time
- Cloud-based support from the EMIS vendor to provide performance management and expert troubleshooting to resolve complex issues in real time

Initial results of such an integrated approach show benefits can be substantial. Achieving 3–10% cuts in energy consumption or carbon emissions is often possible without capital investment in new equipment. Where energy systems are constraining process performance, sites have realized 1–3% increases in throughput or yield, with the synergy between process and energy optimization leading to benefits far greater than considering either in isolation.

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