Energy Management for the Process Industries

***Francisco Alanis* describes a model based, integrated approach for reducing energy operating costs and sustaining energy performance.**

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Energy management for the process industries is becoming a competitive necessity. Manufacturers must capture opportunities to reduce energy use and emissions, and at the same time increase bottom line profitability.

An integrated approach for reducing energy operating costs and emissions considers both the steam and power utility system (the utility supply side) and the production processes (the utilities demand side). An important component of the solution is provided by a rigorous model-based energy management system, which can be used to help take advantage of potential savings which have hitherto been largely unexploited in addition to providing optimised and consistent information about a site's key processes and facilities for decision-makers.

This knowledge can be useful both in long-term, strategic decisions and in concluding energy supply contracts, in preparing budgets and in drawing up investment plans, as well as in optimising the energy costs of ongoing operations in real time – online optimization based on current operation, utilities demands, costs and plant availability.

By implementing an energy management programme with elements focusing on both supply and demand, organisations can achieve significant returns – sometimes over 15 percent of their annual energy costs with very attractive payback on the capital invested.

Supply & demand

Site Energy Management can be broken down into two key areas: reducing energy demand and consumption, and reducing the supply costs of the energy used. An effective energy management plan must address both sides of this energy equation simultaneously.

The supply side includes public utilities and the site's utility plant; we will just call this "utilities" for short. The demand or consumption side includes all production processes and operations that consume fuel, steam and power. Figure 1 illustrates a simplified layout of a typical industrial site.

For Energy Supply, the site's utility system provides the utilities the production units require. High pressure (HP) steam is usually generated in steam boilers. Where gas turbines are installed, HP steam is also generated in heat recovery steam generators (HRSG) to recover heat available from the exhaust of the gas turbine.

Medium and low pressure steam (MP, LP) is generated by letting down HP and/or MP steam through steam turbines. Let-down stations between steam headers balance steam requirements. The steam generation boilers can usually burn fuel oil, fuel gas or both.

Power is usually generated in steam turbines. These could be steam turbines that drive rotating equipment (pumps and compressors) or steam turbo-generators that generate power and may include back pressure and condensing stages. Power can also be generated in gas turbines. Power can be imported (or exported) from the grid to close the site's power balance.

When it comes to Energy Demand, the production units usually require steam at different pressure levels, as well as fuel and power. Steam is used for heating, stripping and tracing. Fuel is used in fired heaters.

Power is required by pumps and compressors. These power requirements can be supplied by electric motors and/or steam turbine drives.

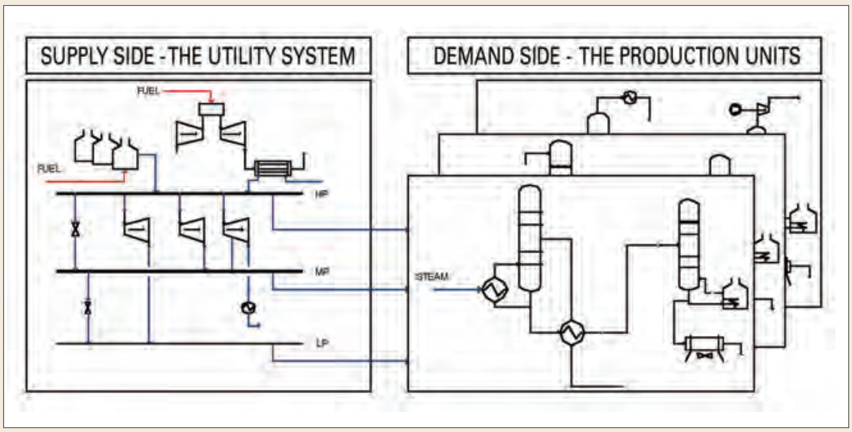

Figure 1: A typical industrial site's supply and demand sides.

Managing energy supply

The goal in the utilities side is to reliably generate the energy the processes require in the least expensive and most efficient way possible.

Fuels consumption and electricity import/export define the utilities operating costs. The following operating decisions will have the major impact on fuels use and power import/export:

- Choice of boilers and their loads (boiler load allocation)
- Choice of power generation turbines and their load (power load allocation)
- Choice of fuels
- Choice of drives (motor or turbine)

Additionally, system constraints and fuels and electricity contracts will also impact final operating costs and emissions. System constraints may include boiler hot standby requirements, boiler capacity as a function of fuel used, fuel mix ratios, emissions limits, and equipment items that must be on because of reliability. Energy contracts may include minimum and maximum rates, take or pay clauses, penalties, and hourly tariffs.

As a result, finding the optimum equipment set up to achieve lowest operating cost requires a system that takes into account equipment performance as a function of load, equipment interactions, system constraints and energy contracts.

A model-centric system like AspenTech's Energy Management and Optimization (EM&O) based on *Aspen Utilities* meets the above requirements. It uses a rigorous simulation model of the site's utilities system. Accurate utilities demands by the process units are also modeled.

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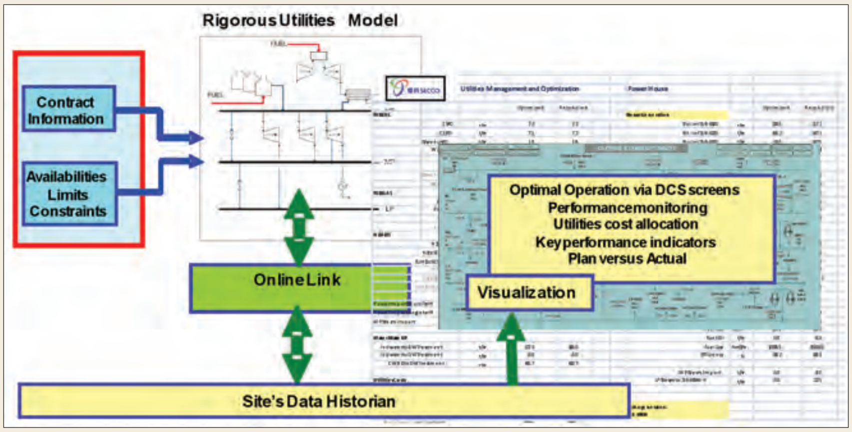

Figure 2: Overview of the On Line Energy Management and Optimization (EM&O) System.

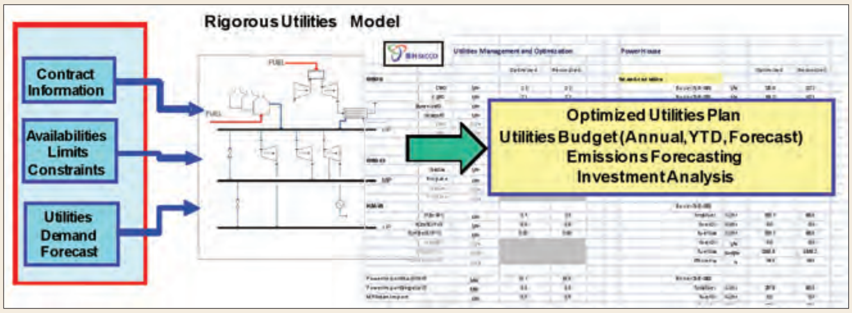

Figure 3: Overview of the Off Line EM&O System.

Seeing benefits

Benefits can be realized through a variety of ways. The main opportunities can be broken down into two main tasks: operational and strategic. Operational opportunities include:

- Maximizing use of most efficient equipment items
- Correct choice and use of fuels
- Correct choice of drives
- Reduced hot stand-by
- Reduce venting of steam
- Better cost accountancy
- Better adherence to contract terms and reduced penalties

Strategic opportunities include:

- Better purchasing – lower contract price and more reliable nominations
- Emissions forecasts
- Optimum scheduling of maintenance
- Reduced capital investment for improvements in energy efficiency

The operational benefits are achievable through the On Line functionality of the EM&O system. This allows optimization of the utility system in real time by identifying the lowest cost solution taking into account current changes in utilities demands, fuel and electricity prices, equipment availability and system constraints. It also allows the real time monitoring of equipment performance, emissions, and other key performance indicators (KPI's). An overview of the On Line architecture is provided in Figure 2.

The strategic benefits are achievable through the Off Line functionality of the EM&O system. This allows performing multi-period optimization and "what-if" analyses to identify the best (short to long term) schemes in response to seasonal fluctuations and site changes. Cost savings in the two to five percent range have been made by the applications outlined above with no capital expenditure other than software and dedicated servers or desktop computers. And cost savings in the 10-20 percent range have been made with relatively low capital expenditure on simple changes to the process design of the production units.

Beyond visualization

An effective energy management plan must be holistic, addressing both sides of the energy equation effectively. Monitoring and optimizing both the supply and demand sides simultaneously. They should be designed to sustain the gains as the plant evolves over time, as equipment ages and is modified, as product mix and loading changes. The most effective programs should include at their core, a rigorous model of the utility system as well as continuous improvement capabilities. Simple data visualization is not enough, compared to dashboard display of information synthesized via operating models from real-time data. Energy management must be proactive and become part of the site operations.

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