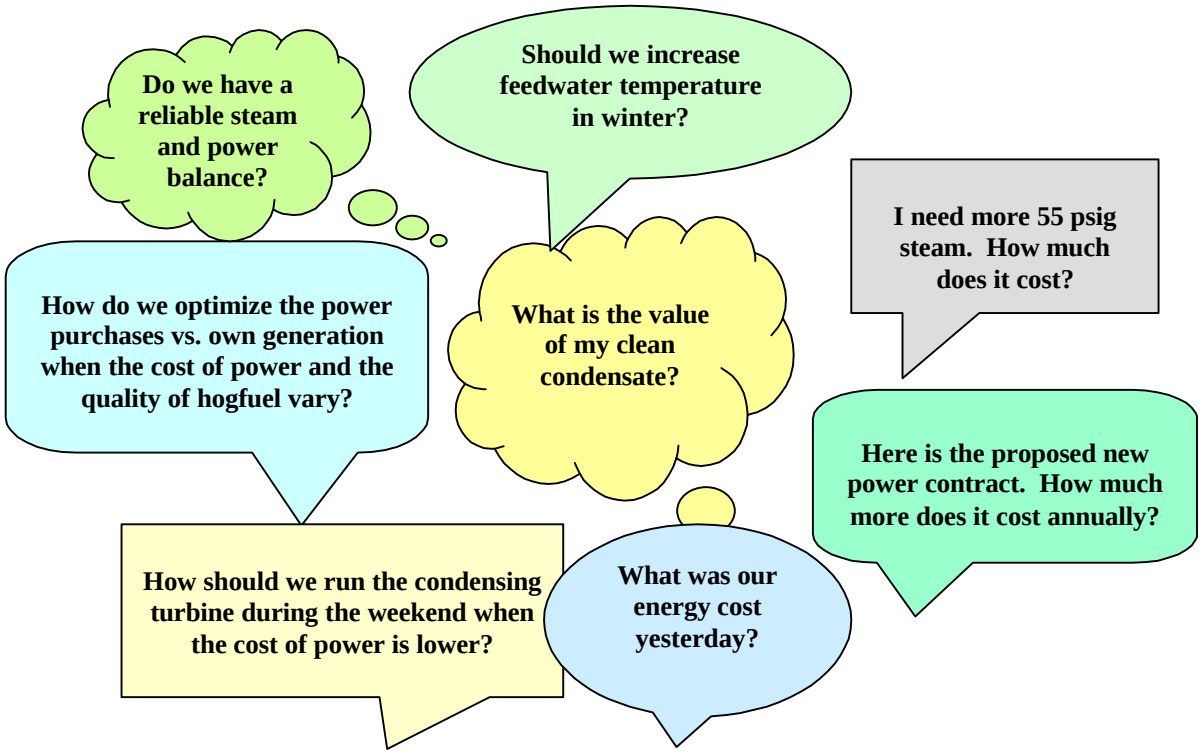
ENERGY OPTIMIZATION
EKONO's Power House Management System "EHAM"



Although there is an abundance of data available, every year many pulp and paper mills throw away substantial amounts of energy dollars without recognizing it. The EHAM energy management system developed by EKONO organizes the data in a useful manner that can be used to optimize energy purchases and minimize the throwaway dollars.

Process and plant data are typically collected and stored in mill databases, from which the unfiltered data is available to everyone. Often the over-abundance and inaccuracy of the data complicates the use of the information in the decision making process. The EHAM energy management system from EKONO provides a coherent method of organizing these data for use in business decisions on a daily, monthly or annual basis. It can be employed to determine the optimum power house operating conditions, track boiler and turbine efficiencies, evaluate annual budgets, define energy and material balances, create various reports or evaluate potential impacts of plant modifications on energy costs.

The EHAM energy management system operates in the Windows environment and utilizes Excel for input and output operations. The built-in linear programming package and steam tables are integral parts of the spreadsheet and no computer knowledge beyond basic Excel functions is required to operate the system. EHAM can be arranged to operate either on-line or off-line depending on the mill-specific objectives and circumstances.

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What is EHAM

Industrial steam and power plants are complex installations that typically consist of several boilers that use various fuels, steam and gas turbines with various steam pressure levels, steam drives on feedwater pumps and air fans, pressure reduction stations, etc. The varying steam and power load together with environmental limitations and complex power contracts makes the optimization of an industrial power plant a complicated task.

EKONO's EHAM energy management system utilizes Linear Programming (LP) complemented with a mixed integer algorithm to model the structure of a powerhouse. The program simulates an industrial powerhouse of virtually any configuration and complexity, calculating balanced energy and material flows in any given operational situation. It can be used either in on-line or off-line mode depending on the objectives.

Accurate mill information on power and steam balances combined with extensive modeling expertise are required to develop a successful power house model. Consequently, in addition to delivering the EHAM software, EKONO will play a key role in ensuring that the model accurately represents the actual operation and the results are reliable.

EKONO's services include:

- assistance in determining of the type and extent of the EHAM system
- development of reliable steam and power balances
- verification of the availability and accuracy of instruments
- development of turbine, boiler etc. models that accurately represent the actual operation of these individual systems
- development of the Excel input/output interface based on the client needs
- model tune-up
- operator training
- documentation: operating and system manuals

What can EHAM Accomplish

Long-Term Optimization

The objective is to optimize long term (e.g. annual budgeting) energy costs when there are limits on fuel availability (e.g., own hogfuel must be incinerated), limits on power generation, environmental discharge limits, planned outages of the main equipment and seasonal variability in the energy demand.

Mid-Term Optimization

The objective is to develop monthly or weekly budgets to minimize short-term energy costs and to determine which boilers/turbines/drives should be operating during the period. Key constraints include the power contract, shutdown requirements, fuel/power generation limits, environmental constraints, main equipment outages or any other limitations in the operation.

Short-Term Optimization

In the on-line option the EHAM system provides a recommendation on the optimum operating mode. Typical key variables that affect the optimum operation include changes in steam and power load, changes in power price, changes in fuel quality or costs and temporary limitations in boiler or turbine capacities.

Reporting

EHAM can be used to develop powerhouse balances and reports, track the deviation from the optimum operating mode, allocate the energy costs between different energy users or to define the marginal cost of steam.

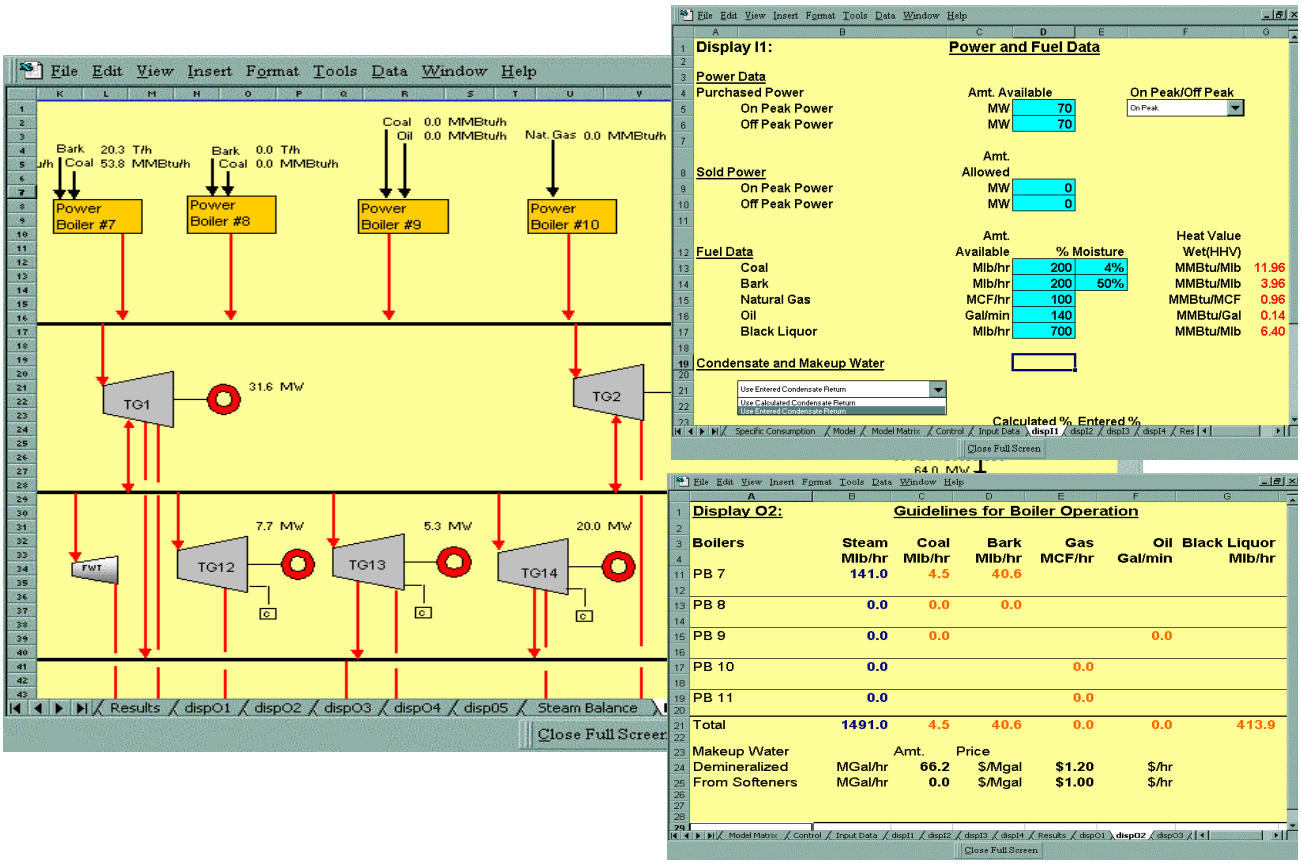
Analysis Tool

An off-line model can be used to determine operating costs for potential modifications in mill configuration: changes in the power contract or fuel costs, changes in operating conditions (condensate return percentage and temperature, feedwater temperature, etc.), and the impact of energy conservation measures or other mill projects.

Instrument Accuracy

The model can be used to statistically find the best fit for the powerhouse balance. Also, if adequate redundancy in instrumentation exists, the model can be used to determine which instruments are most likely giving erroneous readings.

Major Components of EKONO's EHAM System



EHAM and Excel

EHAM is designed for the Windows operating system and uses Excel as a communication link between the user and the model. This interface allows an easy to use format for organizing the information through the use of standard displays, graphs, reports, etc.

Data Import/Export

Since the model input and output data is located in an Excel workbook, standard communication links from other spreadsheets or databases (for example PI, CIM/21 or Aspen) can be used for communications.

Steam Properties

ASME Steam Tables are employed to calculate steam properties. A Dynamic Link Library (DLL) is used to bring steam property data to Excel.

Optimizer

The Linear Programming package provides both linear and nonlinear optimization modes and it forms the optimization portion of the EHAM system. The optimizer is configured to operate as an embedded OLE (Object Linking and Embedding) server. The program also includes a Dynamic Link Library (DLL) to ensure the seamless integration of the optimization routine.

How to Use EHAM

EHAM Input Data Requirements

EHAM data requirements vary depending on mill-specific circumstances and overall objectives. Typical requirements include specification of:

- and cost of purchased power and fuels
- boiler efficiency characteristics and allowable operating steam and power demand
- availability, quality ranges
- turbine characteristics and operating ranges
- structure of the electrical system and its limitations (transformers, circuit breakers, etc.), characteristics and operating alternatives for steam drives
- pressure reduction valves and their capacities
- steam network structure and limitations (line capacities, flash tanks, steam accumulators, etc.)
- steam conditions (pressure and temperature)
- environmental limitations and potential costs of treatment (air, solid waste, cooling towers)

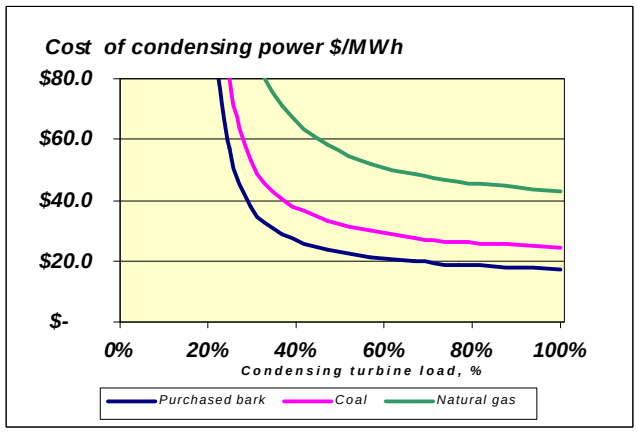
EHAM Results

The EHAM system can be used to determine powerhouse balances and costs based on historical data or it can be used to determine the optimum operating mode for given operating limitations. These data are readily available in an Excel spreadsheet and they typically include:

- steam and power balances
- fuel/power consumption and cost
- guidelines for boiler operation
- guidelines for turbine, PRV and condenser operation
- marginal steam prices

Sample Case

As an example, consider a powerhouse consisting of a condensing turbine and several power boilers capable of burning bark, coal and natural gas. The power contract has a variable rate depending on the time of the day and day of the week. During typical operating conditions the steam demand fluctuates as production rate changes and sheet breaks occur at the paper machines. The cost of steam generated in the power boilers depends on the fuels used and the boiler efficiencies. The task is to optimize the fuel usage and power purchases to minimize the overall energy costs.



As the graph above illustrates, the marginal cost of own power generation varies considerably depending on the condensing turbine load and the type of fuel used in the boiler. Steam generated with natural gas can provide lower cost electricity when the cost of purchased power reaches its peak. Conversely, condensing power generated with bark-steam can be more expensive if the condenser is only partially loaded. The EHAM system from EKONO would be able to provide the optimum operating strategy in all of the above situations and would give the operators recommendations on the best possible operating mode.

EKONO Inc. is an independent consulting engineering company specializing in energy, environmental and process engineering for the pulp and paper industry. For more information about EKONO's EHAM system, please contact:

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