Energy Management Systems

Basic information on key systems

The use of information technology is critical to the SEB efforts to increase plant efficiency and reduce transmission and distribution losses. Computers can help at all levels of operation in power systems. At the generating unit level they can help increase efficiency, reliability and availability. At the transmission level, they help “match” demand and supply, preventing simultaneous surplus and shortage situations. In the distribution system they help manage load, maintain quality, detect theft and tempering and thus reduce system losses.

Some of the systems are specific to a particular area – generation, transmission or distribution. Most of them, however, overlap different areas. Almost all can be classified under energy management systems category.

Supervisory Control and Date Acquisition (SCADA)

The purpose of SCADA is to allow operators to observe and control the power system. It supports both energy management and distribution automation. It is critical to a power system in general and to transmission and distribution in particular. The system consists of a master station that communicates with remote terminal units (RTUs). RTUs transmit device status and in turn receive control commands.

The specific tasks SCADA performs are:

Data Acquisition provides measurements and status information to operator.

Trending plots measurements on selected time scales.

Supervisory Control allows to remotely control devices such as circuit breakers.

Training restricts operation of a device within specified parameters and prevents unauthorised operation.

Alarms informs operator of unplanned events and undesirable operating conditions.

Logging logs all operator entries, all alarms and specified information.

Load Shedding provides for both automatic and operator initiated tripping of load in response to system emergencies.

It can range from compact, standardised systems to large and tailor-made ones. Communication is mostly via dedicated circuits.

Plant Monitoring and Control

Power plant automation is critical to maximising efficiency and availability. It also helps optimise fuel utilisation and lowers operational costs. The three major systems for power plant monitoring and control are:

Process Control System – This is a closed loop control system which takes its direction from EMS and automatically collects plant data by reading instruments. Physical and electrical parameters associated with the boiler, the turbine and the generator are monitored on a continuous cycle basis. Alarms and events are logged. Control of pumps and switches for routine functions and for start-ups or shut-downs is provided.

Plant Monitoring System – This is strictly data collection system for fuel monitoring and performance calculations. Data is stored and retrieved to prepare reports and performance analysis. These help plant management, load dispatchers and planning groups.

Operational Monitoring System – This is used by plant operators to enter manually collected operational data for record keeping, report writing and analysis.

In addition to these systems, the power plant may also use computers for security systems, environmental systems, controlled access systems and chemical analysis systems.

Power Plant Maintenance

Power plant maintenance system stores pertinent information for analysis of maintenance costs and evaluation of equipment performance. The interactive portion of the system provides power plant personnel with the capability to enter problem data, planning data and work execution data. Interactive functions are also provided for entry and maintenance of an equipment database and for access to equipment history.

Because of its varied data requirements, the maintenance information system also has interfaces to other computer systems within the utility. These are the materials information system for equipment stocking levels, the personnel information system for labour resources and the general accounting system for cost tracking.

Fuel Management System

As fuel is the single largest expenditure in power plant operations, control of fuel costs represents the most substantial contribution to the overall economy of power production. A key function of a fuel management system is to aid in the procurement of fuel. It also facilitates monitoring and performance of fuel supply contracts. Accounting functions are used for fuel purchases, transportation costs, fuel usage and inventory value. Fuel management system integrates the load forecast, generation scheduling and despatch information. This information is then used to optimise fuel allocation.

Automatic Generation Control

AGGs perform a very critical task – they adjust generation against load. The objective is the maintenance of quality and minimisation of costs – of energy production and transmission. This is done primarily through load frequency control and economic despatch. Both these functions are done in real-time.

Load Frequency Control (LFC) monitors generation load, constantly looking for imbalances. LFC is needed to maintain:

- frequency at the scheduled value. A much lower or higher frequency can lead to tripping and system outage and damage to the end-user equipment on the other.
- net power interchanges with neighboring control areas at the scheduled values. Power systems which draw energy from neighbouring areas need to do so in a specified manner so that neither transmission lines nor generating units are overstressed.
- power allocation among generating units at economically desired values. It is important that plants suited to meet peaking demand are utilised when this situation arises.

Economic Despatch Different generating units that are on-line have different costs of generation. It is therefore necessary to optimise the contribution (or generation level) of each of these units so that the load is met at the minimum cost. The system takes into account not only the per unit generating costs of power plants but also their geographical location. This enables the despatch manager to minimise the transmission losses and thus achieve the true "minimum cost". Other factors such as reserve margins and transmission limits are also considered.

Load Management

The objective of load management application is to improve the load factor (the ratio of average load to peak load) and to shed selected load during emergency conditions.

Most utilities have some form of load management. It can range from consumer guidance (voluntary) to complete control and metering of the consumer's load. It is the latter that requires more help from IT. One such load management system that is IT- enabled is load curtailment system which relies on automatic meter reading.

At a system level, SCADA can provide status and measurements for distribution feeders at the substation. Distribution automation equipment can monitor selectionalising devices (switches, interrupters, fuses); operate switches for circuit reconfiguration; control voltage; read customers' meters; implement time-of-day pricing and switch customer equipment to manage load. This equipment significantly enhances functionality of distribution control centers.

Load Despatch

The purpose of a load despatch system is to balance the overall supply and demand in the transmission. It is especially important when there are simultaneous surpluses and shortages in different power systems which form a part of the transmission grid.

Since transmission systems provide negligible energy storage, supply and demand must be balanced by adjusting generation to match load. It is possible to adjust generation, within a certain range, by controlling turbine generators at the power plants. It is also possible to manage load by " shedding" it when demand hits a critical level.

In addition to managing supply and demand, these systems also serve to monitor and control the quality of power delivered by one system to the other. They ensure that key criteria like frequency and power factor are strictly adhered to by the grid members.

Security Control

Power systems need to survive all possible contingencies. A "contingency" is an event that causes one or more important components such as transmission lines, generators and transformers to be unexpectedly removed from service. "Survival" means that the system stabilises and continues to operate at acceptable voltage and frequency levels without loss of load.

Security control systems execute the following tasks sequentially:

- Determine the state of the system
- Process list of contingencies to determine the consequences of each on the system
- Determine preventive or corrective action for those contingencies which represent unacceptable risk.

Power Distribution Automation system

At a centralised load centre, data like current, voltage, power factor, breaker-status, etc. is telemetered and displayed. This gives the operator an overall view of the entire distribution network, thus enabling him to exercise effective control on the entire network. The display of the network would enable the operator to issue instructions for optimising the flow in the event of feeder overload or low/high voltage through switching in/out of shunt capacitors, synchronous condensers and load management.

This in turn would lead to improvement in voltage profile, reduction in power loss, improvement in reliability, quick detection of fault and restoration of service. Studies abroad have revealed that after the introduction of distribution automation, there has been significant reduction in distribution loss because of more effective management of the network. The loss reduction has been two to three per cent in these developed countries which have low T&D losses. The reduction is likely to be much higher in a country like India.

Metering

Intelligent and automated metering systems are critical to management of distribution. Energy audit meters can help in load forecasting and load management at the system level. Intelligent energy meters can help manage load at the customer level. They can also detect theft and tampering. Together, they help minimise distribution losses.

Customer information and billing system

Utilities need to bill their customers in a timely fashion. Faster meter reading means faster billing. And faster billing means improved cash flows. The simpler systems only focus on computerised billing. The more sophisticated ones go many steps further.

They store critical customer information such as average usage, age of account, change of address, history of payments and seasonal patterns. They assist utilities in credit control and financial management.

A number of these systems now also offer a metering element. This may be in the form of remote metering or hand-held meter readers which can retrieve information from the customer site and download it into the billing system. The benefit is the reduced time lag between meter reading and billing.

In fact, a number of companies are now offering spot billing which enables the utility employee to issue the bill to the customer on the spot right after the meter has been read.

Reference book:
Power Line, Volume 2 No.10
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