INFORMATION TECHNOLOGY: WHAT ROLE WILL IT PLAY AFTER Deregulation?

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As open access leads to retail choice, competition between energy service providers becomes more intense. Information is fast becoming the key to profitability, customer retention, market advantage, and growth.

The operational and commercial needs of the power industry require information systems to perform both traditional real-time operational functions (SCADA, EMS) and to meet new competitive realities.

The innovative use of information technology (IT) is a key way to lower costs, improve customer satisfaction, grow market share, and offer new products to enhance revenues. Companies must integrate proven best-of-breed legacy IT systems and operational systems, and offer new "products" to enhance revenues. Companies must integrate proven best-of-breed applications and systems from various suppliers rather than develop large, expensive, and customized systems.

THE IT CHALLENGE IN THE POWER INDUSTRY

As utilities transform themselves to compete on a global basis, legacy IT systems and traditional solutions are being replaced on a grand scale. But before embarking on a major overhaul of a utility's information system, several questions should be addressed:

1. Should the legacy system be replaced entirely or can it be upgraded?
2. Are the customer and/or utility benefits quantifiable?
3. What are the initial costs and future costs for installation, expansion, maintenance and training?
4. What are the needs of various groups inside the utility?
5. What groups within the utility should be involved in the design requirements?

Business-responsive IT requires a smooth integration of traditional IT systems for financial, regulatory, and risk management; for engineering and operations data; and for customer care (see Figure 1).

Figure 1. Utility Information Needs

(continued on Pg. 2)

COGENERATION ENERGY OPTIMIZATION

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Distributed Plant Monitoring (DPM) is rapidly becoming a necessity within the increasingly competitive electric power generation marketplace. Many cogeneration facilities with monitoring systems currently in place are moving to the next level of plant productivity through the implementation of an energy optimization system. This article discusses the general requirements and benefits of a cogeneration optimization system, with particular reference to PTI's APOGEE optimization software.

The objective of an energy optimization system is to minimize the total energy operating costs (fuel, energy purchase, consumables, maintenance, etc.) of bulk power, process steam and/or product load profiles. This includes the purchase of external power and/or steam vs. the use of internal self-generation equipment.

Typical applications involve optimization of equipment commitment and dispatch in response to current power and/or process steam supply requirements. This optimization is being extended into energy end use equipment where the commitment and dispatch energy of process equipment (e.g. turbine/motor driven compressors, pumps, power and/or steam fed processes, etc.) is simultaneously optimized to meet production needs.

Optimizing energy end use arises in many applications. In industrial plants, the energy used by various processes (e.g., chemical production, refining, etc.) constitute end use applications where optimization can yield large savings. The auxiliary systems in power plants and industrial cogeneration facilities are examples where motor and turbine driven combustion air fans, pumps, fuel handling, equipment cooling towers, compressors, etc. constitute significant energy consumers for dispatch optimization.

Since energy production and end use processes constitute an integrated system, optimization may require a consideration of the total problem to achieve optimum results, rather than optimizing individual segments.

OPTIMIZER DESCRIPTION AND CAPABILITIES

PTI's cogeneration optimization package, APOGEE, includes all steam generators (e.g. boilers) and electric generators (e.g. steam turbines), the steam headers that connect them, and any valves or vents connected to the steam headers. The external modules are the individual process loads and other

(continued on Pg. 3)
In the past, these different systems typically were procured independently by different departments. Today they must be integrated into an efficiently functioning environment to provide customer-driven business solutions.

Utility legacy systems tend to have the following attributes:
- Vertically integrated, massive applications
- Slow implementation and development
- Lack of provisions for extension, upgrade, and portability
- No apparent or documented software architecture

However, the critical attributes of business-responsive systems include:
- Clearly identified and prioritized business goals
- Aligned engineering and business processes
- Fully integrated applications in the overall architecture
- Rapid implementation and deployment
- Extendability

Thus the future power industry will require an overall IT architecture and integrated data model that supports different data requirements, flow rates, and integrity among the various systems. It must also be able to evolve with new technologies to avoid obsolescence.

ENERGY DELIVERY IT ARCHITECTURE

The information systems shown in Figure 2 are those typically considered in an energy-delivery IT strategy. Different utilities prioritize and emphasize these systems differently. They also have different underlying technologies and data models.

Energy delivery requirements are characterized by three basic data components - energy, assets, and work activities. Energy data contain information on availability, capacity, inventory, control, and metering of energy products. Asset data contain information about network facilities and related geographic information (streets, rights of way, etc.). Work activities data contain information about construction and maintenance work orders and outages.

Application components are defined for geographic information system, work and outage management, and real-time systems. The applications communicate with the databases to provide:
- Customer service differentiation and marketing to facilitate proactive communication with customers. It can automate information such as outage occurrence or updated estimates of service-restoration time.
- Performance based rates - deliver higher revenue in return for service reliability and quality. For accounting, DMS can provide required data and documentation. For business planning, DMS can facilitate historical data analysis for the setting and targeted marketing of PBR.
- Reliability-centered maintenance - maximizes the maintenance budget by focusing on equipment that needs maintenance most, and which more greatly impacts system reliability. Maintenance needs depend on the operational, failure, and outage history of the equipment, which can be tracked by the DMS.
- Valued-based planning - decisions on network planning required to meet customer expectations of service quality, in addition to energy demands. DMS can support reliability analysis, a cornerstone of value-based planning, with systematic records of operations and outage histories.

Far more value is at stake in the transmission and distribution (or "wires") business than many realize. As a natural monopoly, wires will continue to be regulated. Wires owners will need to provide transmission and distribution access on a nondiscriminatory basis. They will face obligations to connect customers, maintain reliability, and possibly act as a supplier of last resort. In most cases, regulation will be based on performance rather than cost.

Fortunately, performance-based regulation (PBR) creates an attractive business opportunity. Companies that can negotiate and execute well against PBR mechanisms will enjoy returns that exceed their cost of capital. The winning US wires companies will be good at negotiating favorable PBR schemes, controlling costs, promoting load growth, and dealing effectively with bypass threats.

Bypass will be the chief danger for wires players. The potential for bypass will increase as distributed generation technologies (photovoltaics, fuel cells, and microturbines) improve. Also, large transition charges placed on the wires will intensify the threat by pushing large customers and municipal utilities to new heights of creativity.

Some wires companies will seek economies of scale by consolidating activities and assets with other local utilities such as gas and water utilities, and municipal and co-operative electric companies. Others will look for growth through geographic expansion, nationally and internationally. As in generation, there will be international opportunities for growth. An estimated $100 billion in assets may come on the market through privatization over the next five to ten years.

In many developing economies, transmission and distribution investments have lagged generation additions. Wires companies with world-class skills in system expansion, operation, and maintenance will find attractive opportunities around the globe.

As deregulation, divestiture, convergence, and globalization take hold, traditional energy providers must manage their organizations and operations better. On top of radically changing management practices and regulatory requirements, power traders can also seize the initiative by implementing risk management techniques similar to those traditionally used by the financial markets — real-time spot and futures markets, national power trading, and support for variable levels of service quality.

SUMMARY

The success or failure of a company in the new energy marketplace will depend on its use of information as the cornerstone of future strategies. The company that can move information around quickly, analyze it accurately, and apply it effectively will have the competitive edge.
COGENERATION ENERGY
(continued from Pg. 1)

external steam requirements such as heating. These load modules may use power and/or steam energy to satisfy their respective loads.

The optimizer is designed to be generic. It can be configured through user input to have any number of steam headers, steam generators (e.g. boilers) on any header, steam turbine generators between any headers (including to condensing), pressure relief valves (PRVs) between headers, and vents off the headers.

This generic expandable approach allows the optimizer to be configured to a small system (such as the example system described below) as well as to a much larger and more complicated energy system (such as a large chemical processing plant) by editing a configuration form within a DPM client.

The optimizer is capable of running in several different modes. The simplest is the unconstrained solution. This is where all equipment and steam headers are operating within their respective limits and require none of the vents or PRVs to open. The constrained mode exists when steam headers, boilers or turbines are operating at their limits. This requires that PRVs and/or vents must open to either release excess steam or provide the processes with steam. Another mode to consider is the economic choice of whether or not to generate steam or provide the processes with steam. Another mode to consider is the economic choice of whether or not to generate electricity versus buying or selling it to the outside grid through a tie-line. This mode results in PRV's opening to bypass turbine generators and/or loading up the turbine generators, thereby needing the vents to be opened.

In a large complex system with many steam headers it is possible to see any number of the above modes in different sections of the optimizer.

In the majority of cogeneration plants the energy supply system is an entirely separate entity from the process load system. The process, having its own operating strategy, typically specifies only a required process steam load profile for its steam supply headers. The energy supply system then optimizes itself using the optimizer to satisfy the required load profile. It is the process specified steam load profile that determines which of the above modes will be applicable.

EXAMPLE SYSTEM

To demonstrate how PTI's APOGEE Optimization System operates in conjunction with a DPM, an example cogeneration configuration shown in Figure 1 is used.

![Figure 1](image)

The configuration consists of four steam headers, two single auto-extraction back pressure steam turbine generators (TG1, TG2), two boilers (B1, B2), three PRVs between the steam headers and one vent off the lowest pressure steam header.

Figure 2 is an example display of the results of an optimization calculation. The process steam load profile, the house steam load profile, the auxiliary (internal) electric power load, boiler fuel costs, and tie-line power costs are all specified as inputs to the optimizer. Also required by the optimizer are the equipment characteristics which can be determined and accessed through the DPM data. Since a DPM uses on-line calculations to determine the equipment characteristics, these characteristics reflect the actual characteristics of the equipment instead of "design" values acquired at manufacturing time or during an outdated test.

Figure 2

Referring to the results, it can be noted that with the exception of Header 135 the steam demand profile is such that the turbines are unconstrained and that no bypasses or vents are required to open. The PRV leading to Header 135 is open due only to the fact that there are no other steam paths after that header and that there is a process steam load present on that header. The incremental steam cost on the top header (A) reflects the incremental cost of steam from the boilers. The steam costs on the lower pressure headers are less since there is a credit from producing electricity by passing steam through the turbine generators. There is no incremental credit or loss through the PRV, so the incremental steam cost on the 135 psi header is the same as that on the higher pressure header (B). Since the auxiliary KW load is high, tie-line power must be purchased to satisfy the load not picked up by the generating turbines.

These results are displayed to the operators for consideration in their dispatch or fed to an automatic dispatch system.

SUMMARY

An energy optimization system such as PTI's APOGEE can yield significant savings, often offering a payback of less than one year. It is essential however, that the distributed plant monitor (DPM) data utilized in optimization calculations be accurate and current. The optimization system must recognize changes in equipment input/output relationships and provide operating recommendations based upon real time operating conditions.
**FUZE SAVING AND ITS EFFECT ON POWER QUALITY**

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**Power Quality and Reliability Tradeoffs With Fuse Saving**

Since the majority of faults on overhead distribution are temporary (the fault will be cleared if power is interrupted and restored), temporary faults on lateral taps can be cleared by the feeder breaker before the lateral fuse blows. This is usually done with the instantaneous element of the breaker relay or recloser in the substation. This practice is known as fault selective feeder relaying or simply as "fuse saving".

A downside is that all customers on the feeder will experience a blink for most lateral faults. Because of the momentary interruptions, many utilities are choosing to operate in a fuse blowing (breaker-saving) mode.

Many commercial and industrial customers are more sensitive to momentary interruptions than voltage sags, so removing the fuse saving should be an improvement. However, some who are very sensitive to voltage sags may have reduced power quality under the breaker-saving scheme (because feeder faults will cause long duration voltage sags without the instantaneous element).

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**COORDINATION OF CIRCUIT BREAKERS AND FUSE LINKS**

Many utilities are deciding to allow the fuse to blow since, for much of the circuit, attempting to clear the fault via breaker operation doesn't save the fuse. Because the distribution feeder breaker is slow compared with typical lateral fuses, it is difficult for the fuse to coordinate with the breaker. Assuming that the relay takes one cycle to operate, and the breaker takes five cycles to operate, the total operation time is six cycles (0.1 sec). The most commonly used fuse type in the U.S. is the K link, which is a fast fuse. The coordination points of a five-cycle breaker with several K links are shown in Table 1. The coordination point is taken as the current magnitude where the fuse damage curve (the minimum melt curve shifted down 25%) crosses the breaker plus relay time (0.1 sec). The damage curve takes into account preheating and other effects not included in the test curves. For fault currents above the values in Table 1, the fuse will operate.

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<th>Fuse Link</th>
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(continued on page 5)

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**PTI CONDUCTS INTERNATIONAL STRATEGIC PLANNING MEETING**

A special strategic planning meeting was conducted for PTI's Value-Added International Partners (V.I.P.) Group on May 3-7, 1999. The V.I.P. group includes PTI's wholly-owned subsidiaries in England and India, joint ventures in Malaysia and South Africa, and representatives from 30 other countries. With half of PTI's business conducted overseas, the V.I.P. group is a vital component of the company's continuing business expansion.

The strategic planning meeting brought together an impressive cast of individuals who serve the rapidly deregulating electric power industry in their regions. The twenty-two attendees, pictured below, represented Argentina, Bulgaria, Costa Rica, El Salvador, Greece, India, Korea, Norway, Pakistan, Peru, Malaysia, New Zealand, South Africa, Spain, and the United Kingdom.

The strategy meeting had two main objectives:

1) inform participants about the latest products and services offered by PTI to meet the needs of the rapidly changing power industry around the world, and

2) explore ways to unify the V.I.P. Group, capitalizing on their diverse geographic and technical expertise, to better serve the worldwide electrical energy marketplace.
FUSE SAVING AND ITS EFFECT
(continued from Pg. 4)

For the most commonly used lateral fuses (65 and 100 K), the
treater cannot save the fuse over most of the length of typical circuits.
Under most conditions, the fuse will blow and the breaker will trip.
 Knowing this, many utilities are disabling the instantaneous and allow­
ing the fuse to blow. Why subject customers to a momentary when it
isn’t very effective?
  However, there are a number of important things to keep in mind
when disabling the instantaneous. These include longer voltage sags
and equipment damage (with wire burndowns being of most concern).

Wire Burndown

Burndown can be a problem if either a covered conductor (tree
wire) or a small bare wire is protected by the substation breaker. If the
instantaneous element is removed, then the time overcurrent relay
must clear faults on the mains. This will greatly increase the duration
of faults that can cause wire damage or burndown.

Conductor burndowns are caused by the heating action of the fault
current arc on the wire. Although bare-wire construction can suffer
burndowns, covered conductor construction is much more susceptible.
Normally, on open wire construction, the fault arc will move along
the conductor from a motoring action caused by the magnetic forces from
the fault current, so the arc is never concentrated at one point on the
wire. But covered conductors will prevent this movement, so it will
dwell at one point on the conductor. All of the heating action of the arc
will be concentrated on a small section of conductor.

Burndowns cause permanent interruptions by faults, such as light­
ning, that normally would be temporary. Burndowns also can produce
safety hazards from live wires on the ground.

UTILITY PRACTICES

Many utilities have mixed practices. The results of a 1996 PTI sur­
vey showed that of those utilities with mixed practices, most would
decide it on a case by case basis. Some operated normally in a fuse
saving mode, but if significant power quality complaints were received,
then it was changed to let the fuse blow. A few indicated that fuse sav­
ing was not successful, so it was not used. Other interesting responses
included:

• One utility normally operates in a fuse saving mode, but on
  problem feeders with many momentaries, fuse saving is dis­
  abled. After the problem areas are isolated (by letting the fuse
  blow) and fixed, the fuse saving scheme is restored.

• Two utilities use an instantaneous element with a time delay.
  This allows most fuses to blow but limits the duration of the
  fault (which would reduce burndown and some long duration
  voltage sag concerns).

• One utility uses SCADA to switch between fuse saving and fuse
  blowing modes. Normally, the fuse-blowing mode is used, but
  during storms, it is switched to a fuse saving scheme.

OTHER SCHEMES TO CONSIDER

Time Delay On The Instantaneous Element

One option is to use an instantaneous relay element with a time
delay. Most fuses are allowed to blow, but the fault duration is limited
by the delayed instantaneous. This reduces the duration of voltage
sags and reduces the chance of wire damage and other problems asso­
ciated with longer duration faults. A common delay time is 10 cycles.

Partial fuse saving may also be obtained with a delayed instantane­
ous element if a shorter delay is used. This would allow small

Percent of Utilities Using Fuse Saving
Per IEEE Surveys

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<tr>
<td>100%</td>
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Figure 1. Power quality survey results on the use of a fuse saving
scheme (n=60).

second stage fuses to blow, but may still be able to save large lat­
eral fuses (like a 100 or 200T).

Another option is to use two instantaneous elements in a scheme
to save the fuses for low-current faults but allow fuses to blow for high
current faults.

High-Low Scheme

Another scheme to consider involves disabling the instantaneous
element at the substation, but enabling it at a downstream feeder
recloser. Upstream of the recloser, fuse saving will not coordinate
because of high fault currents, so the instantaneous element of the
substation breaker is disabled. Downstream of the recloser, fuse saving
should work; reclosers are generally faster, and the fault currents are
low enough downstream of the recloser to coordinate.

SCADA Control

Another protection scheme that can be used is to selectively change
between fuse saving and breaker saving mode with SCADA.
The normal operation would be in a breaker saving mode. During
storms, it would be switched to a fuse saving mode. During storms, the
cost (overtime pay) and impact on reliability indices (customers are out
longer as crews are stretched) of fuse operations is higher. Also, cus­
tomers are slightly more forgiving of momentary interruptions during
storms.

Advanced Options

• Seasonal Control of the Protection Scheme: During the active
  summer period, the feeders would be operated in a fuse saving
  scheme to reduce the load on crews and improve reliability dur­
  ing that time.

• Adaptive Control by Phases: If the fault is on more than one
  phase it is not on a lateral (assuming all laterals are single
  phase), then the circuit should trip on the instantaneous. This
  will reduce the long duration voltage sags for faults on the
  mains. If the fault is only on one phase, then let the fuse blow
  by going to a time delay or delayed instantaneous element.

• Time-of-Day Control: During the day on weekdays, the feeders
  would be operated in a fuse-blowing scheme to improve power
  quality (especially for commercial loads). Reliability would not
dergrade as much since crews would be easily available.

• Instantaneous Reclose: From a power quality point of view, a
  faster reclose is better. Some customers may not notice any­
thing more than a quick blink of the lights. Many residential devices such as the digital clocks on alarm clocks, microwaves, and VCR's can ride through a half-second interruption where they probably cannot ride through a 5-second interruption (a typical reclose delay used at many utilities).

The choice between breaker and fuse operation is a complex one involving tradeoffs in power quality, customer interruptions, and equipment damage. Distribution protection engineers should be aware of the potential pitfalls associated with each philosophy, recognizing the customer loads served by the particular circuit. There are a number of creative solutions that can help to minimize the net effect of customer interruptions and power quality issues.

For a more detailed treatment of this topic, please see http://www.pti-us.com/pti/consult/dist/papers/fusesaving/fusesave.htm.

RECENT PUBLICATIONS

For further information on any of the following publications, please contact:

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Author(s) and (Affiliation) | Publication Title | Date & Occasion of Presentation
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P. Barker (PTI), K. Elsholz (AWS Scientific), and A. Peterson (Niagara Mohawk Power Corp.) | Modular Distributed Generation Unit Improves Reliability and Quality of Electric Power | March/April 1999 - Power Delivery, Volume 8, Number 2, PennWell Publishing Co.
### FALL 1999 and SPRING 2000
### COURSE SCHEDULE

*Courses will be presented at PTI Offices in Schenectady, NY, unless otherwise noted*

<table>
<thead>
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See more course listings on reverse side
# SPECIAL COURSES OF STUDY

conducted at Power Technologies, Inc. Corporate Headquarters, Schenectady, NY

<table>
<thead>
<tr>
<th>COURSE TITLE AND DATES</th>
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| Transmission Line Design and Upgrading  
- A Four Week Course of Study -  
May 1-26, 2000 | This training program will allow both experienced and novice transmission line design engineers to review and upgrade their skills and learn how to apply the latest materials and design techniques. The course will cover both design of new lines and upgrading of existing lines over the full range of HV and EHV voltage levels. |
| Distribution System Engineering  
- A Four-Week Course of Study -  
June 5-30, 2000 | This course offers a comprehensive curriculum in distribution system engineering including system design, protection, equipment applications, economics, and distribution system planning. Participants will have the opportunity to examine new technologies and become familiar with the latest industry trends to increase system efficiency and reduce costs. Distribution engineers wishing to broaden their technical skills and improve their ability to meet the challenges of today's utility environment will find this course valuable. |
| Power System Transmission Planning and Analysis  
- A Six-Week Course of Study -  
September - October 2000 | A comprehensive approach to gaining the practical knowledge necessary to effectively use and apply power engineering analytical tools and methodologies in transmission system planning. The course includes sessions on planning concepts and principles are combined with intensive "hands-on" use of PTI’s PSS/E program, application workshops, and study tours of utility sites for a broad-based learning experience. |

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Occasionally, unforeseen events or insufficient enrollment may necessitate the cancellation of a course. If a course is canceled, PTI will attempt to notify each registrant no later than 14 days prior to the start of the course. PTI is not responsible for any cancellation charges imposed by airlines, hotels, or travel agents.

### Registration Note

It is recommended that you register one month before any course. Registrations will be accepted within the month time frame but space may be limited.

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### For further Information on courses or registration

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