Software solutions for the liberalized electric energy industry

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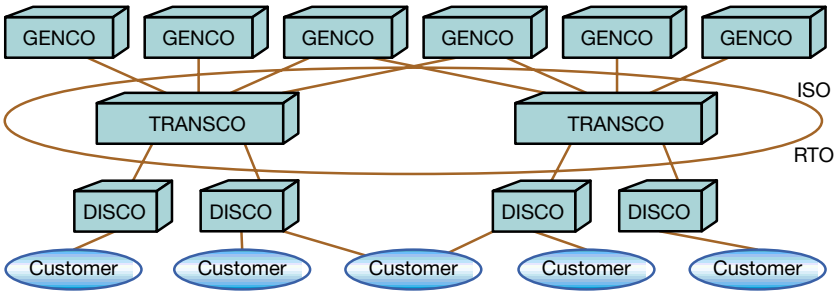
Few products can lay claim to 'just-in-time' delivery the way electricity can. When you flick the light switch, you expect light. Right away.

The industry that delivers this on-demand power is undergoing huge changes; liberalization and the consequent restructuring of the industry have introduced many new players to the business of producing, delivering and trading electricity.

Such a complex market can only be mastered by an overlay of eCommerce-dominated business processes – mapping new patterns of ownership and trade onto the existing physical control systems. ABB has long been a leading supplier of software solutions designed to meet the challenges posed by liberalization.

1 The vertically integrated utility is being replaced in many markets by separate generating, transmission and distribution companies (GENCO,TRANSCO and DISCO), refereed by the ISO or overseen by the RTO.

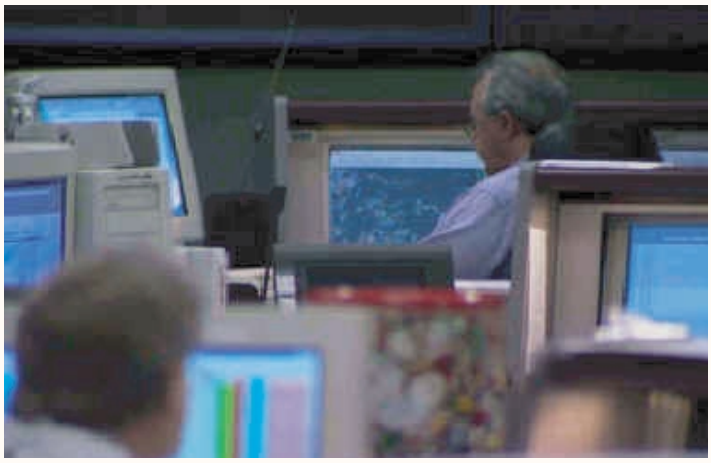


Although the liberalization of the electric utility industry varies according to each country's history of assets ownership and operation, some commonalties, such as those shown in 1, are emerging.

The generation companies are unregulated and function in a fully competitive market. The transmission system owners provide open access to all generation and distribution companies, including their own affiliates, on a non-discriminatory basis. Transmission access is typically regulated or coordinated through mutually agreed access rules. Distribution companies own the distribution networks and the connections to the customers. Regulations or mutually agreed rules typically also apply to distribution companies, guaranteeing third-party access.

To avoid a free-for-all and to preserve the security of the supply, some kind of 'referee' is required. This is the *Independent System Operator* (see box below). In some markets there is a logical need for regional organization of transmission, which is where the

Who's watching?

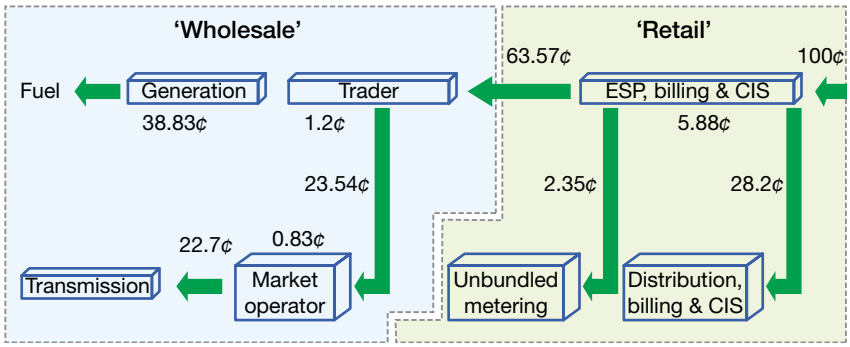


A transmission system has to be operated in a secure manner while ensuring non-discriminatory access to all parties. This task has in some markets been assigned to an *Independent System Operator* (ISO) who maintains operational control of all transmission assets, regardless of their actual ownership. An ISO controls the power system without special interest, and owns no part of the generation, transmission or load infrastructure. Its job is to run the system fairly, to the benefit of all market participants.

The ISO is often governed by a Board of Directors, none of the members of which are affiliated with a market participant.

Often, organizing transmission on a regional basis makes a lot of sense. *Regional Transmission Organizations* (RTOs) can be for-profit companies that own transmission assets but otherwise operate with the independence and scope necessary to provide secure and impartial access to all users of transmission.

2 How a customer dollar is distributed. Customer information systems (CIS) and billing functions are integrated separately into the operations of the distributors and the energy service providers (ESP). Interactions between participants are typically eCommerce software applications.



Regional Transmission Organizations come in.

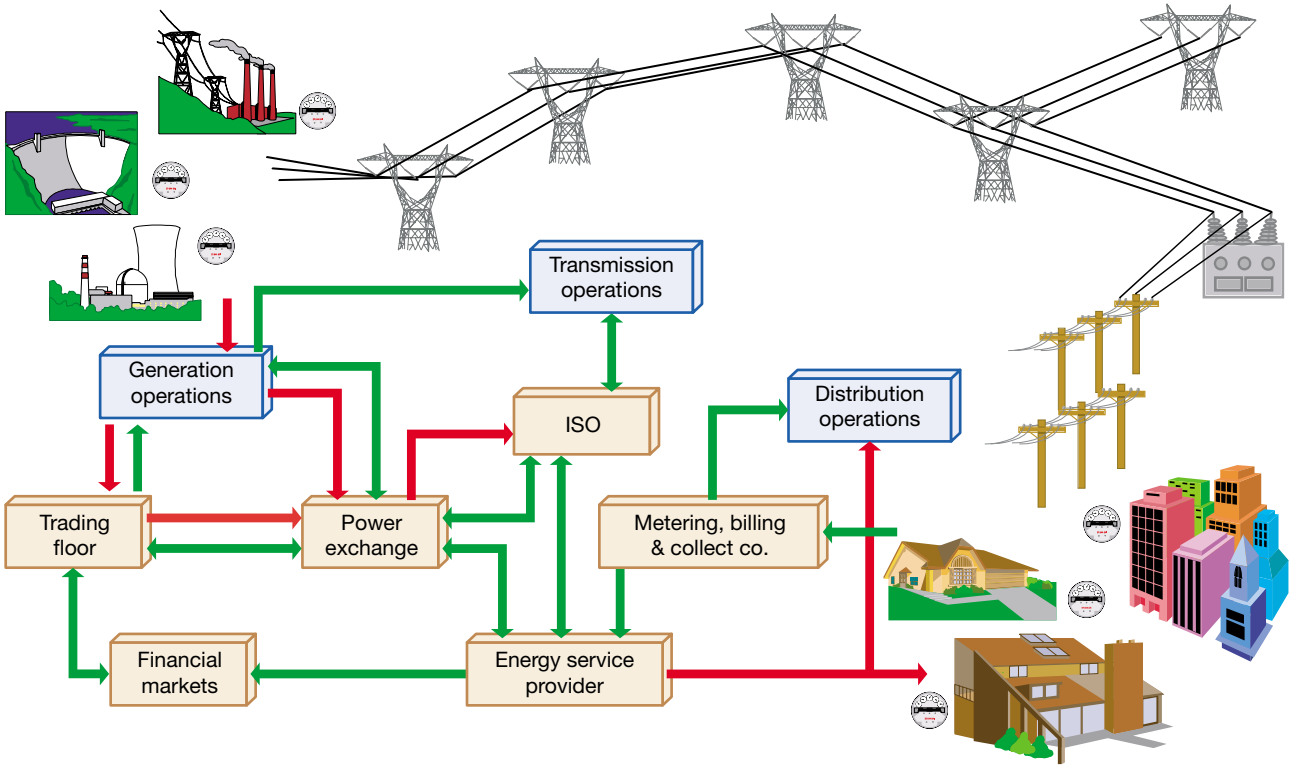
As the verticality of the market has diminished, its breadth has correspondingly increased. Mergers and acquisitions of similar companies operating in different regional markets have made it now extremely common for companies to own assets which are widely distributed geographically and which operate simultaneously in several regional electricity markets.

The new value chain

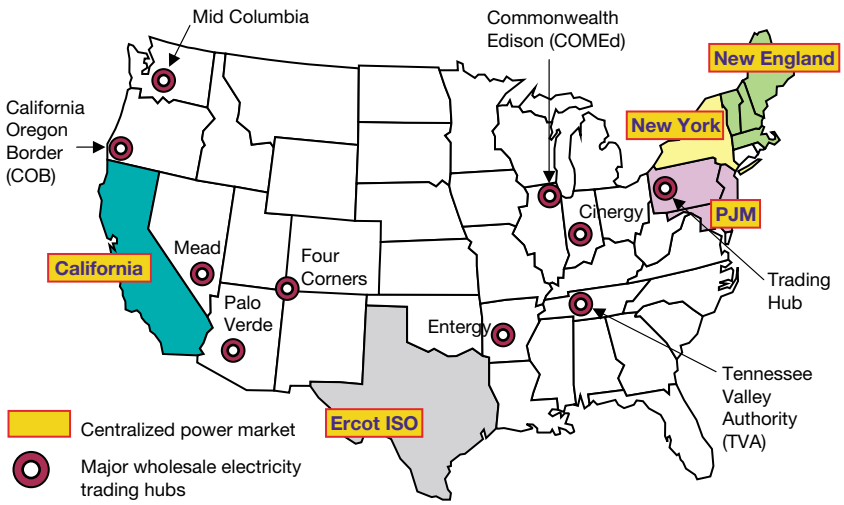
2 represents a typical new value chain. Deregulation has brought new roles and new players (see box on page 36).

Of course, ABB has traditionally provided leading-edge software for the traditional operations (blue blocks) shown in 3. What is new is ABB's software for automation of the business processes within each brown block and for the necessary decision support tools. This software also automates the

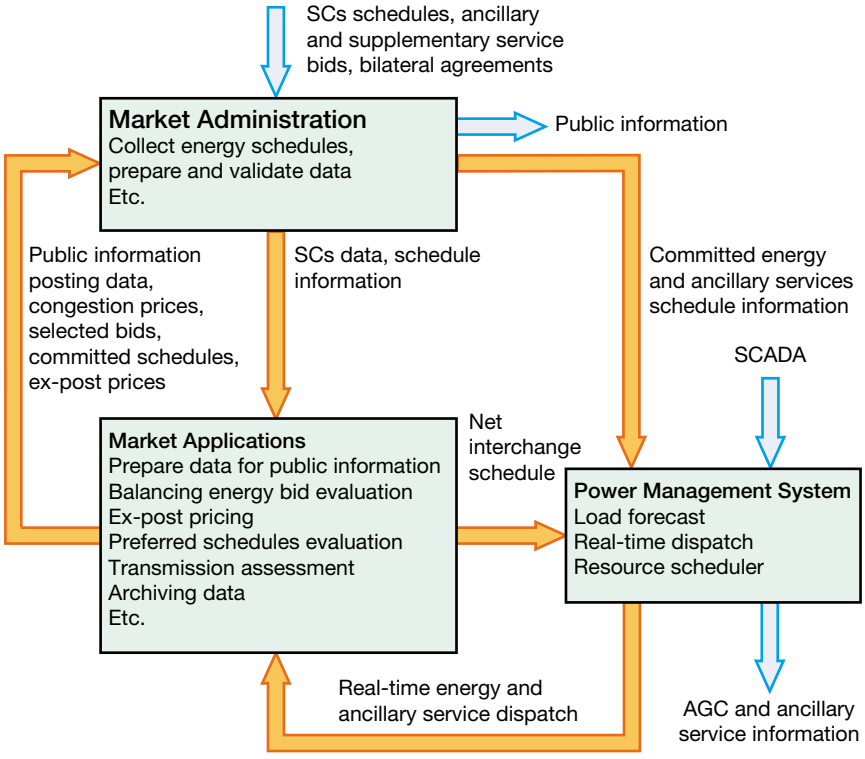
3 New and traditional players. Green flows indicate money, red the ownership of energy. Not shown but implicit are the information flows between the blocks that facilitate the exchange of energy and services for money.



4 Trading Places – major US wholesale electricity centralized power markets and trading hubs. Hubs are delivery points where the ownership of energy changes hands; they are also linked to electricity futures markets established by the New York Mercantile Exchange and the Chicago Board of Trade.



5 Major components and functions of ISO software



implicit information flows between blocks.

Billions of dollars are traded annually in this deregulated world. The need for an adequate IT infrastructure is particularly acute given such a trade volume and the rapid pace of change.

ABB software for central markets

There are two basic market models – the *pool model* and *bilateral trading*. Most implementations combine aspects of both. In a strict pool model, all energy is traded through a central pool or power exchange. Bilateral contracts, on the other hand, permit buyers and sellers to negotiate directly with each other for price and terms of delivery.

Sellers are generators or power marketers. Buyers are wholesale or retail customers or aggregators representing groups of customers. Day-ahead and hour-ahead energy auctions are typical.

4 shows the central markets currently in operation in the USA. Energy is not the only commodity traded. Ancillary services, such as reserve capacity, regulation, reactive power, voltage control, and black start capability, can also be traded.

In addition to providing a mechanism for energy trading, a central market must also operate the transmission system in a fair and secure manner:

- Provide open access to the grid through a non-discriminatory tariff
- Schedule all power through the grid and balance grid operation

- Monitor transmission limits and manage transmission congestion using market signals
- Competitively procure and operate ancillary services
- Provide information to all market participants

Most central market operations allow for the presence of parallel energy markets in addition to the central power exchange. Here, balanced supply-demand bids must be submitted, typically through Scheduling Coordinators (SCs) – entities authorized to submit to the ISO a balanced generation or demand schedule on behalf of one or more generators, and one or more end-users. The software functions ABB supplies which allow the ISO to do its job are shown in 5.

The *Market Administration* component provides a market interface for Scheduling Coordinators and serves as a market information management system. Communication with market participants is via the Internet. In addition to collecting and verifying schedules received from Scheduling Coordinators, the Market Administration component provides forecasts for load, ancillary service requirements, planned transmission outages and congested transmission paths. It also publishes market clearing prices and congestion prices.

ISO personnel use the *Market Applications* component to evaluate the submitted schedules against the state of the transmission system and then establish committed operational schedules.

The *Power Management System* component performs real-time dispatch coordination and transmission security assessment.

The ISO software is also required to manage transmission congestion through market mechanisms (see box on page 38).

ABB software for wholesale & trading

This segment of the liberalized industry operates in a very competitive environment. Deregulation means new profits for companies that own and properly manage generation assets.

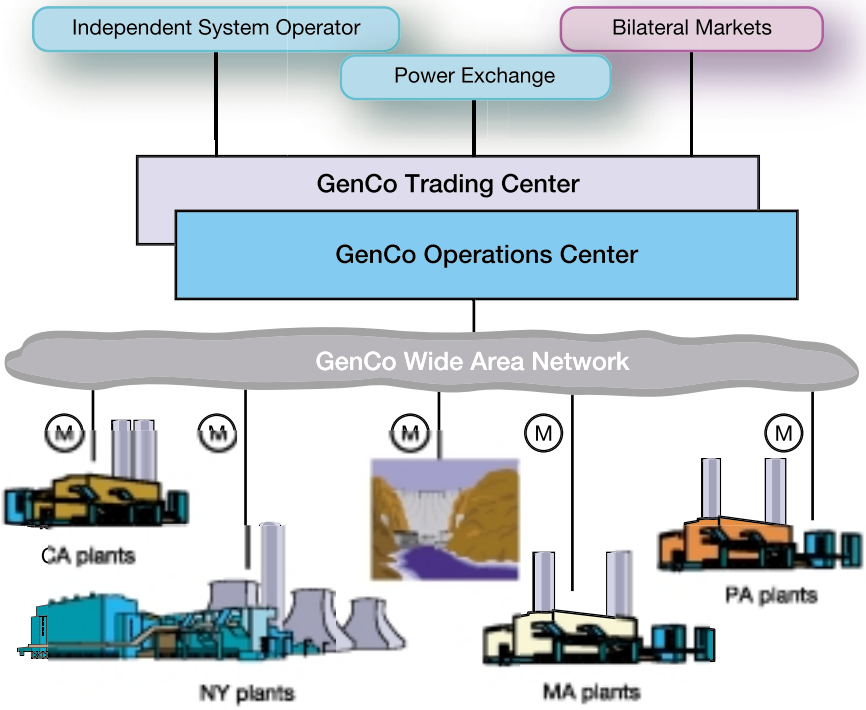
A typical GenCo/trader's operating environment is shown in 6.

Centralized Information Management with *gimsplus*™

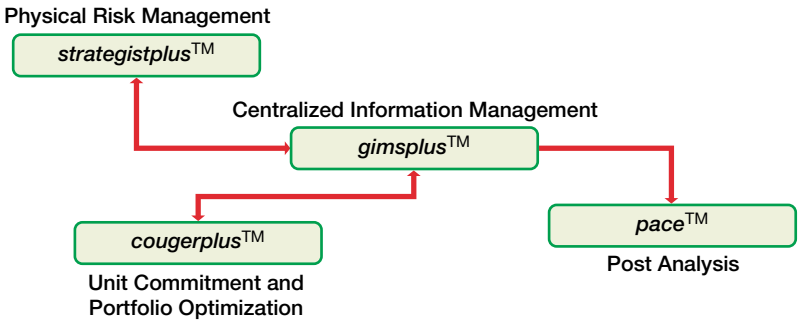
Managing generation assets in the developing electricity marketplace is a complex undertaking. It requires participants to have both operating and market experience and near real-time data at their disposal. Near real-time data is absolutely critical to be able to effectively trade assets in the marketplace, minimize the corporate risk profile, analyze the corporate position, respond to electricity and fuel opportunities, and

6 GenCo trading environment – wholesale generation and trading of energy

CA *California* MA *Massachusetts*
NY *New York* PA *Pennsylvania*



7 Wholesale software solution suite



New faces

Energy Service Providers (ESPs) interact directly with the customer and buy electricity from traders or generators.

Traders or marketers. In a deregulated environment, electricity is traded competitively at the wholesale level. In many cases, owners of generation assets set up trading floors and assume this trading function internally. Sometimes, the ESPs assume a trading function as well.

Market operators coordinate all electricity trade while assuming the security/reliability functions of the physical grid. They also organize and run the electricity markets. They operate transmission from unbundled wire companies, and sell their services to the electricity traders.

finally to just manage the company assets to minimize operation costs.

This is where ABB's *gimsplus*™ software solution suite comes in.

ABB's *gimsplus*™ software solution suite 7 is an enterprise asset management system designed to enable a GenCo to operate effectively in a competitive energy market. *gimsplus*™ integrates the business processes within a GenCo: fuels; operations; trading; risk management; accounting; and the generation assets.

The *gimsplus*™ modular design can automate the day-to-day exchange of information required for trading in an open competitive market as well as manage the complexities of central market interfaces.

It matches asset availability against commitments to determine the margins available for sale, or purchase requirements. Multiple commodities (fuels, generating capacity, energy, ancillaries, etc) are tracked.

gimsplus™ makes information from critical sources available in a timely manner, easing access to an array of decision support tools, tracking market position and resource status, and archiving data and decisions for post-analysis. It facilitates, with the support of the appropriate application modules, risk analysis, market forecasting, resource pricing, scheduling and market participation.

The application at the core of the software provides a database for current, historical and planning data, and mathematical models for the physical generation portfolio.

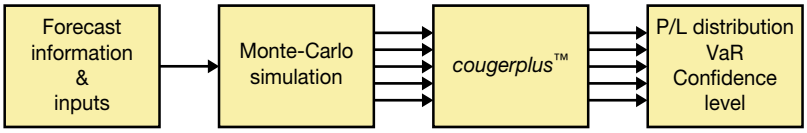
Generation unit scheduling with *cougerplus*™

The key analytical component in this software suite is *cougerplus*™. This application program determines optimum generation unit schedules given availability and cost information about fuels and power plants. It also includes the possibility of reserve capacity, energy trades and even emissions constraints. Detailed models of generating unit performance including ramp rates are included in the calculation of optimum generation schedules. The calculated results include, in addition to the generation schedules, the corresponding cost of generation and fuel and the cost/revenue from energy trades. *cougerplus*™ is widely used and has saved utilities 1 to 3% of system operations costs. The *cougerplus*™ optimization engine is used by the other analytical applications, such as PACE™ and *strategistplus*™.

Post analysis with PACE™

The PACE™ application program uses actual generation data and *cougerplus*™ to perform after-the-fact analysis. It

8 *strategistplus*™ block diagram



calculates actual operating costs and compares them with hypothetical optimal operating costs.

strategistplus™ for risk and portfolio management

Wholesale electricity prices can be very volatile, requiring GenCos or traders to balance risk between stable long-term bilateral contracts and spot market pool trades. The *strategistplus*™ program provides physical risk management and portfolio management. By combining powerful Monte-Carlo simulations of operations and trading with the flexible modeling of market uncertainty, *strategistplus*™ can quickly and accurately identify risk exposure.

It models a wide range of generating units as well as fixed bilateral and pool auction transactions. It can also handle financial instruments such as forward contracts and put and call options as part of a resource portfolio commonly used as hedges against risk.

Major sources of uncertainty (weather, load, fuel price, outages hydro generation irregularity) are factored in. 8 shows a block diagram of the solution approach used by *strategistplus*™. Randomly generated scenarios are analyzed by the *cougerplus*™ engine. The output of *strategistplus*™ is a probability distribution of profit and loss.

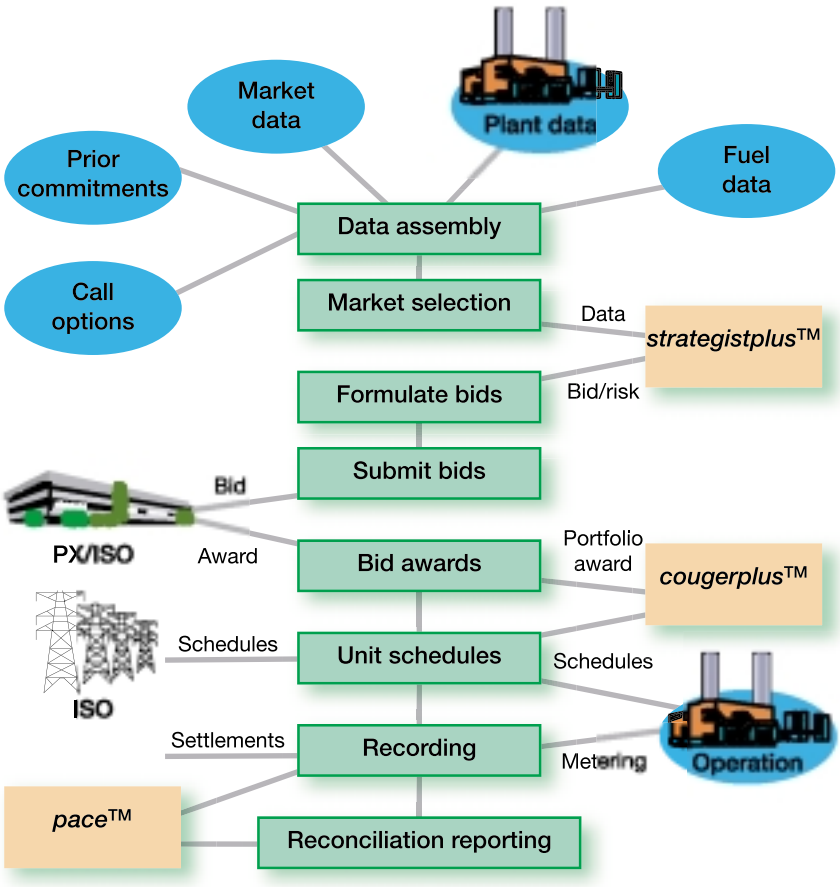
Full automation

The entire suite of wholesale applications allows for full automation of the bid and settlement process as shown in 9. All bid submissions, confirmations and settlement steps are fully eCommerce-supported. ABB software has proven programmatic interfaces to all the major central market operations in North America.

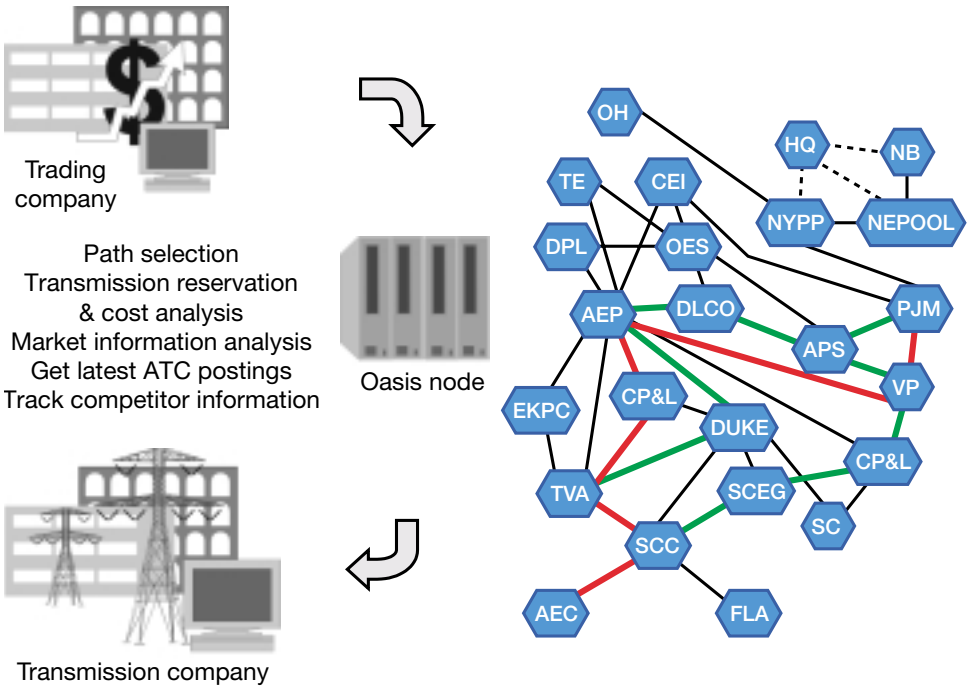
ABB software for transmission

The securing of transmission for energy delivery occurs in the USA in two distinct steps: a *reservation step*, followed by a *scheduling step*. All transmission providers are required to provide open access to transmission services, and to post information about Available Transfer Capability (ATC) on an Online

9 Bidding and settlement process



10 *webmerchantplus*™ functions



Access Same-time Information System (OASIS) server. Any market participant can access this server over the Internet to determine the availability and price of transmission service and to make a reservation for such service.

Next, the actual scheduling of transmission is accomplished through the transmission provider's proprietary EMS scheduling system. The lack of industry standards for scheduling systems led to the National Electric Reliability Council requiring the use of an electronic tagging system for transmission scheduling. Tagging is the transfer of transaction information from a market participant to a transmission provider for the purpose of

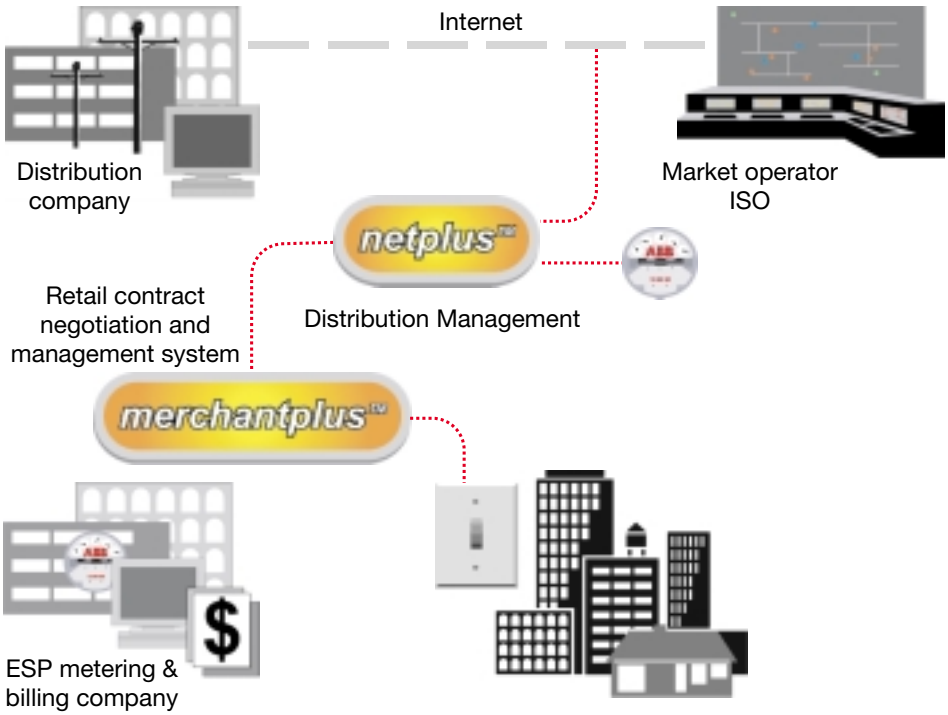
Congestion

In normal operation, the market matches bids and offers from energy producers and users and quickly sets a market clearing price.

This works fine if there are no constraints. However, if there is, say, a capacity limit on a cable running from zone A to zone B, then that may have to be compensated for by providing power generated at a, perhaps more expensive, zone B generator. This adds so-called congestion costs, which are managed by Locational Based Marginal Pricing (LBMP). LBMP means that marginal prices vary from one location to another to account for transmission constraints (congestion) and losses between the locations. LBMP provides a method of fairly and efficiently pricing the use of transmission between locations when congestion exists.

In the long term, this provides an incentive to build more resources in the location where the price is high.

11 The ESP's and distribution company's retail software requirements are met by *merchantplus*™ and netplus™, respectively.



security assessment or congestion management.

ABB provides software for all this. *webmerchantplus*™ 10 extracts information currently posted on any OASIS node. It implements queries for all available transmission paths and their ATC and price data, submission of a request for transmission, queries for the status of a pending request, and confirmation receipt of an accepted request. It can determine the lowest cost path and alternates. The Tag Agent module in the software application *tagmasterplus*™ creates and electronically submits tags to the appropriate authority. (See also box on page 40.)

ABB software for retail

Deregulation and customer choice have also had major impacts on electricity retailing. Energy Service Providers (ESP) now compete energetically for customers based not only on a simple price for electricity but also on complex individually tailored rate structures and on packaged services. For example, some ESPs specialize in 'green' power to attract environmentally conscious customers. Residential customers will increasingly be provided with choices as deregulation proceeds.

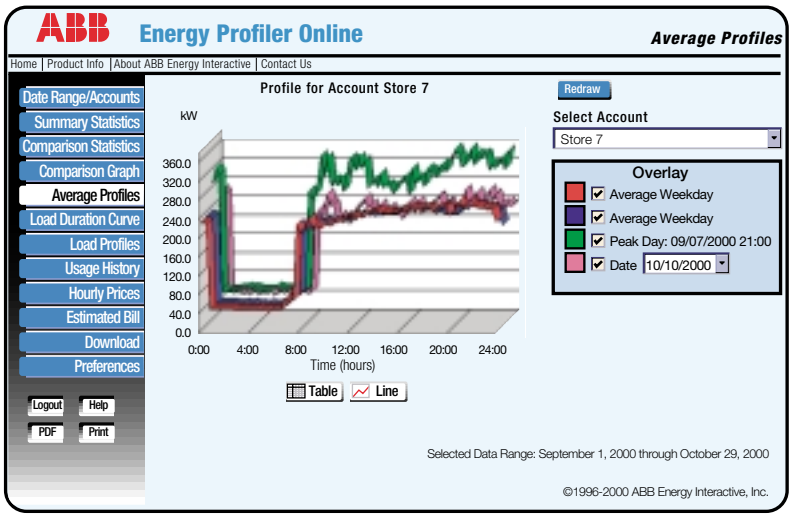
The distribution company provides fee-based open access to ESPs in return for a fee for the use of the network. The relationship between customers and ESPs is not necessarily restricted by geography and may span multiple distribution companies. This situation presents requirements for new software tools for the ESPs, for distribution companies and for customers.

ESPs require tools that permit them to provide quotes to, enroll, manage and bill customers. Distribution companies need to manage the association between customers and ESPs and to ensure that the correct metering data is available to all participants, as well as to calculate the correct use-of-system charges. Customers need tools to understand their own energy consumption patterns. ABB has software applications for all these requirements.

merchantplus™ for ESPs

The *merchantplus*™ application allows the ESP to determine the true cost and profit of serving an individual customer, and permits the ESP to design custom services and provide individualized quotes 11. It retrieves and manages all customer information needed, such

12 EPO web interface showing consumption profile



as usage patterns, and provides all the automation and decision support tools needed by the sales force. The application also handles billing and supply management.

Managing distribution with *netplus*™

The *netplus*™ application allows the distribution company to manage the distribution market by registering service providers and managing the enrollment and switching of customers by service providers. Since a changing population of ESPs needs access to *netplus*™, it is available as an Internet application service. The program also provides estimation, settlement, calculation of network use charges and billing.

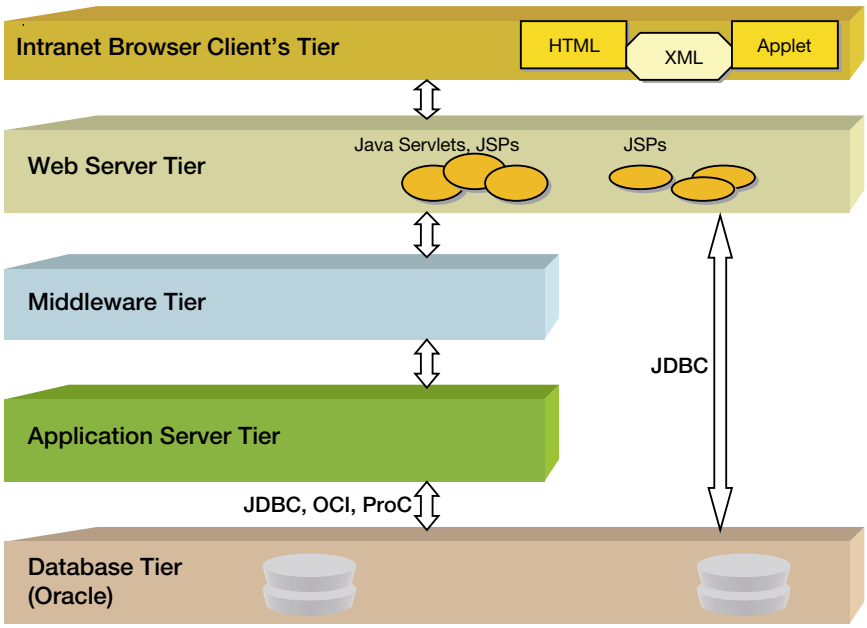
Energy Profiler Online™ (EPO)

EPO is an Internet-based tool for viewing and analyzing interval consumption data. As shown in 12, EPO provides a customer-focused web interface that allows commercial and industrial end-users to quickly identify inefficient energy usage and take corrective measures. EPO also provides end-users with a variety of means for aggregating their energy usage and making comparisons across numerous metering points and accounts.

EPO also provides utilities with the ideal platform on which to build load management programs to improve system reliability. The EPO platform is designed to facilitate the implementation of mandatory load interruption contracts, price-driven, voluntary curtailment measures, and real-time pricing programs. ABB provides EPO as an application service to utility clients that they in turn re-sell to commercial and industrial customers. Each utility client is able to offer the same service but customize and brand the service as his own.

ABB's software applications for transmission providers include:

isplus™ – a program to manage complex high-volume interchange transaction scheduling
eaplus™ – a set of data extraction and reconciliation tools which generate and maintain a database of transaction records for accounting purposes
outageplus™ – an application for managing transmission facility outage information
TRACE™ – a software application jointly developed with the Electric Power Research Institute (EPRI) for determining total transmission capability between points in an interconnection
OASISplus™ – a programmatic interface from the transmission operator to the OASIS web server
tagmasterplus™ – tag authority and tag approval modules implement the transmission provider's side of handling e-Tags.



13 Software architecture overview

Software architecture must be flexible

The liberalized electric power markets are immature and market rules are subject to frequent change. Delays in adapting software to new market rules can translate into very large daily losses for market participants. In addition, there is a fundamental need for widespread access by new market entrants who cannot be assumed to have special software.

This makes it necessary for software to have market rules isolated in an easily customizable application layer and to be accessible over the Internet via a standard browser.

The architecture shown in 13 permits these software applications to be offered as web application services, as exemplified by Energy Profiler Online™. Using these is an attractive alternative for many smaller new market participants.

Finally, technical standards are slowly emerging in this new energy trading world. Together with several leading energy trading exchanges and technology companies, ABB is a founding member of the Energy Trading Standards Group. This group will develop open standards based on XML, the leading language of Internet commerce.

What next?

The energy industry will no doubt continue to evolve rapidly in the regions where liberalization is in full swing, while in other regions the change has not yet even begun!

So there is much to do. In addition, much of the software described here makes full use of the potential offered by the Internet – itself a rapidly evolving world. Given the complexities of today's and tomorrow's liberalized world, it is safe to say that the energy industry will provide an exciting and challenging area for some time to come!

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