Informatics Requirements for a Restructured Competitive Electric Power Industry

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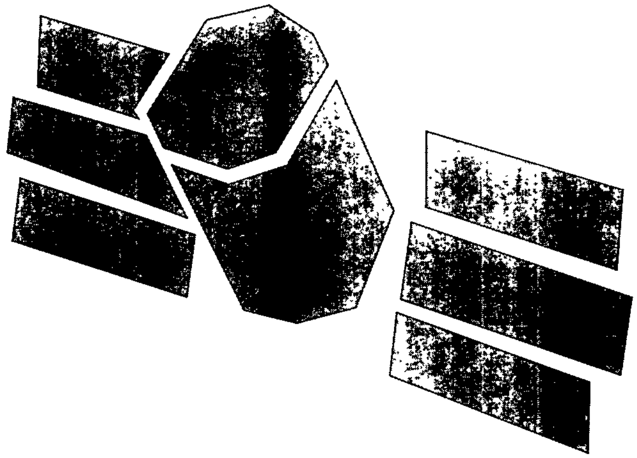
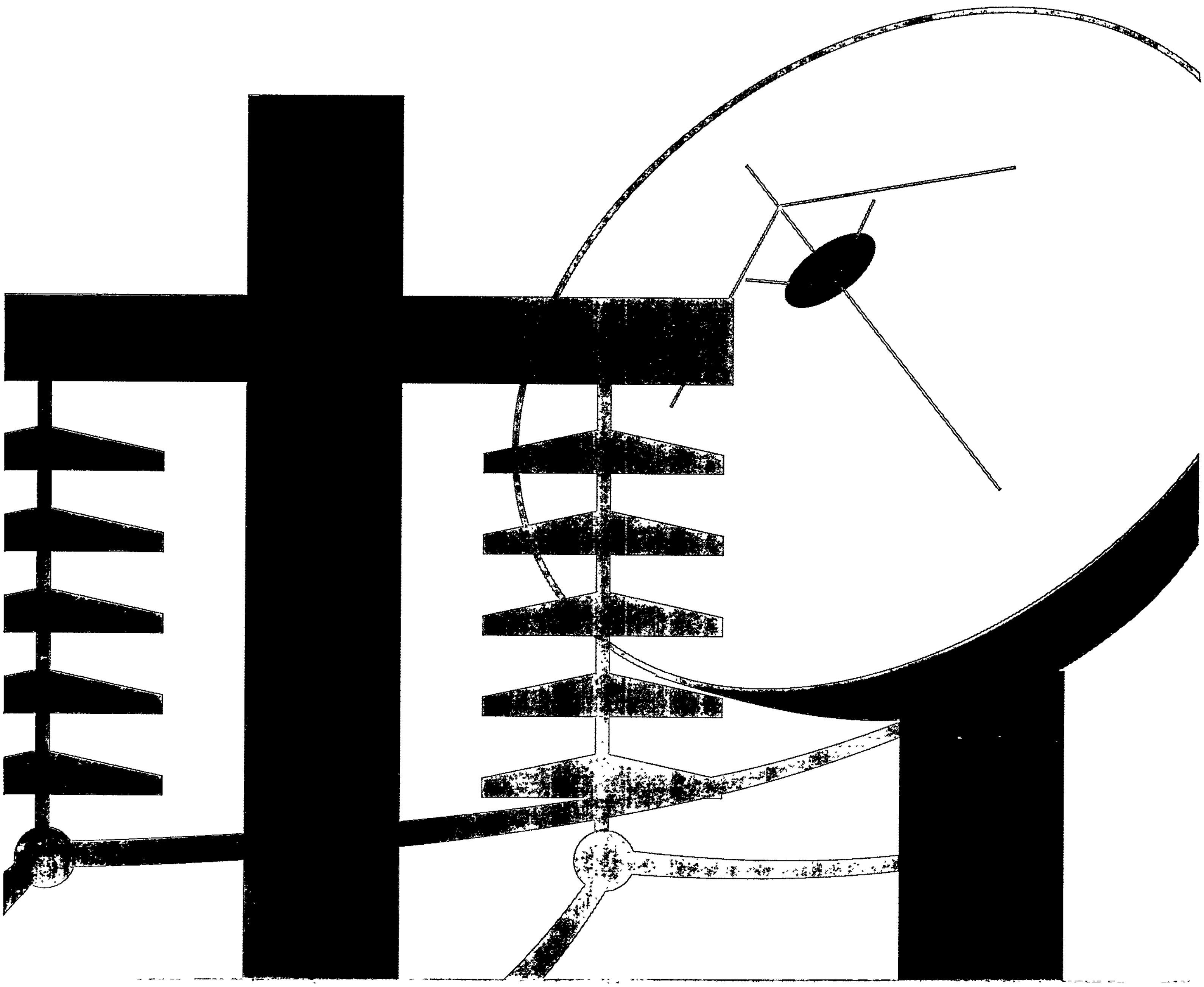


Berkeley, CA April 9, 1996



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WORKSHOP SUMMARY AND PROCEEDINGS

INFORMATICS REQUIREMENTS FOR A RESTRUCTURED COMPETITIVE ELECTRIC POWER INDUSTRY

BERKELEY, CALIFORNIA
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Edited by

Steven Pickle
Chris Marnay
Frank Olken

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EXECUTIVE SUMMARY

Key points emerging from the Workshop include:

1) Information technologies (computing, communications, metering, etc.) are key to the development and operation of competitive electric markets.
2) There is a significant potential for large generators to abuse their market power especially where local monopolies or oligopolies persist due to limited transmission facilities.
3) Theoretical and experimental research shows that institutional design makes a significant difference to resulting prices and profits.
4) Questions of optimal institutional structure are far from settled. There may be opportunities for the use of decentralized market mechanisms beyond current proposals for pool-based markets.
5) Enhancing the price elasticity of demand for electricity will be a key strategy to moderate the impact of supplier market power. Facilitating customer responsiveness will require real-time end-user pricing, effective communications of real-time prices, and end-use control systems such as automatic energy management systems and/or smart appliances.
6) Existing algorithms and computer codes for electric utility operations (e.g., unit commitment and optimal dispatch) are not adequate for competitive power markets. They are unstable and may result in an unfair dispatch of generators.
7) Competitive electric power markets may have a major impact on the economics of distributed renewable power generation.
8) Institutional structures and pricing mechanisms must be designed to assure both short-run allocational efficiency and long-run efficient investment decisions.
9) Given the improvements in emissions monitoring, localized and real-time environmental concerns can potentially be addressed by incorporating variable emissions charges into dispatch costs.
10) The restructured industry will require some regulatory retooling, at the very least to address the vast geographic boundaries of the market. Regulators will need better computational tools to simulate proposed market institutions where generation oligopolies and transmission constraints exit.

The three areas of highest immediate research interest appear to be: 1) design and analysis of industry structures that are economically efficient, politically palatable, and resistant to the exercise of market power; 2) enhancement of customer price elasticity; and 3) improvement of operations algorithms (e.g., unit commitment and optimal dispatch).

OVERVIEW

The electric power industry in the United States is undergoing a slow but nonetheless dramatic transformation. It is a transformation driven by technology, economics, and politics; one that will move the industry from its traditional mode of centralized system operations and regulated rates guaranteeing long-run cost recovery, to decentralized investment and operational decisionmaking and to customer access to true spot market prices. This transformation will revolutionize the technical, procedural, and informational requirements of the industry.

A major milestone in this process occurred on December 20, 1995, when the California Public Utilities Commission (CPUC) approved its long-awaited electric utility industry restructuring decision. The decision directed the three major California investor-owned utilities to reorganize themselves by the beginning of 1998 into a supply pool, at the same time selling up to a half of their thermal generating plants. Generation will be bid into this pool and will be dispatched by an independent system operator. The dispatch could potentially involve bidders not only from California but from throughout western North America and include every conceivable generating technology and scale of operation. At the same time, large customers and aggregated customer groups will be able to contract independently for their supply and the utilities will be required to offer a real-time pricing tariff based on the pool price to all their customers, including residential. In related proceedings concerning competitive wholesale power markets, the Federal Energy Regulatory Commission (FERC) has recognized that real-time information flows between buyers and sellers are essential to efficient equitable market operation.

The premise of the Informatics Workshop was that information technologies—that is computing, communications, instrumentation, data storage, and networking—are key components in the development and operation of the coming competitive electric power industry. The Workshop was concerned both with technologies for use in wholesale electric power markets, such as unit commitment and dispatch algorithms, and with ones related to retail markets, such as metering equipment. The intent of the Workshop was to address two issues:

1) What are the informatics (information technologies) requirements of a competitive electric power industry?

2) What (if any) are the public policy concerns that might motivate involvement on the part of the U.S. Department of Energy (DOE), either in research and development or standards development?

Informatics Requirements:

Informatics are seen largely as enabling technologies for the efficient operation of competitive electric power markets. The areas of research interest that dominated the Workshop are:

1) Design of Institutional Structures
2) Operation of Power Markets
3) Operation of Power Grids
4) Customer Information Systems
5) Consumer Access to Information

The role of informatics in electric power markets is both to ensure stable operations and to lower the transaction costs of trading electric power.

Public Policy Concerns:

One of the key questions facing researchers in technology and electric power deregulation is why should the public (or DOE) care about informatics technology issues in electric power markets? Why not simply deregulate electric power and telecommunications and let the chips fall where they may? Why aren't information technology issues simply matters for internal utility decisions or possibly voluntary agreements among utilities?

Yet as CPUC President Daniel Fessler made clear in his keynote address, the goal of deregulation is not simply to relax regulatory oversight over existing monopoly power providers, but rather to facilitate the creation of truly competitive electric power markets. Public agencies must, therefore, be concerned with the means by which all participants can have equal access to emerging power markets. To facilitate competitive power markets, various schemes are being devised which mandate open access to transmission facilities. Appropriate use of information technology promises to allow for the transition to a fully competitive market for electric power. Indeed, informatics is a prerequisite to solving some of the concerns raised by John Chandley and others about assessing and restricting the market power of major power producers. Ed Kahn reminded his audience that we should not loose sight of the driving force behind the movement to restructure, namely the poor investment decisionmaking in the industry's history and its resulting low capital productivity.

In addition, Steve Rivkin called attention to the potential role of electric power utilities in providing telecommunications infrastructure and possibly telecommunications services to customers. The rationale for such undertakings is quite simple: electric utilities and telecommunications vendors share right-of-ways, i.e., power/telephone poles and underground conduits. The adoption of non-conductive optical fibers makes shared right-of-ways (and even integrated optical/power cables) increasingly attractive. Further, utilities require substantial communications networks to support transmission and distribution automation, real-time pricing, billing, and demand-side management (DSM) of power demands. Because of economies of scale in providing telecommunications infrastructure, electric utilities are potential vendors. Public agencies may well have a strong interest in both promoting and monitoring this type of partnering.

President Fessler and Steve Rivkin also called attention to considerations of universal access by low-income and/or remote customers to both power and telecommunications services. Historically, this has been a major concern of regulators and has led to a variety of cross subsidies in rate structures. Competitive markets will presumably erode or eliminate such cross subsidies, requiring explicit taxes and government subsidies if universal service goals are to be addressed.

As the Workshop speakers delivered insightful and provocative talks on diverse topics and themes, producing a simple summary of the day's events is not a trivial undertaking. Nonetheless, these reporters suggest the following list of areas of agreement and disagreement and direct the reader to the Executive Summary for a short list of Workshop topics:

- *Agreement:* industry restructuring is underway and change is inevitable.
- *Disagreement:* what is the ideal market structure, particularly regarding the danger of market power?

- *Agreement:* current operating methods reflect current industry structure.
- *Disagreement:* will current operating methods will be adequate for the new market structure?

- *Agreement:* new demand-side technologies are ready or on the horizon.
- *Disagreement:* which industry structure and/or public policy will ensure deployment?

- *Agreement:* customer benefits from restructuring are not ensured.
- *Disagreement:* which industry structure and/or public policy can deliver customer benefits?

- *Agreement:* restructuring has environmental implications which must be addressed as part of the restructuring process.
- *Disagreement:* what regulatory retooling is required to address environmental concerns?

The three areas of highest immediate research interest appear to be: 1) design and analysis of industry structures that are economically efficient, politically palatable, and resistant to the exercise of market power; 2) enhancement of customer price elasticity; and 3) improvement of operations algorithms (e.g., unit commitment and optimal dispatch).

I. Welcome and Introductory Remarks

Call to Order:
Stewart Loken
Head of the Information and Computing Sciences Division,
Ernest Orlando Lawrence Berkeley National Laboratory

Welcoming remarks:
Charles Shank
Director, Ernest Orlando Lawrence Berkeley National Laboratory

I am struck by the similarities between the restructured electric power market and efforts in 1980s to deregulate and restructure the telecommunications industry. Just as computerized switching made possible the network reconfiguration and ultimately the decentralization of telecommunications, similar changes and advances in information technology are making possible the rethinking and restructuring of electric power provision. The Lawrence Berkeley National Laboratory hopes to be at the forefront of research in this area and urges on the participants at today's valuable Workshop.

Allan Hoffman
Acting Deputy Assistant Secretary for Utility Technologies,
U.S. Department of Energy

Clearly the driving force in the utility sector today is the prospect of less regulated markets and increasing competition. It's all anybody talks about at any meeting involving the utility sector. There is a tremendous amount of uncertainty in this process but also a tremendous amount of opportunity. And while the uncertainty is causing some pain, in the long-run increasing competition will be better for the nation and better for the utility sector. Potential benefits include the increased use of distributed resources—including smaller generating facilities—and providing not just electrons but improved energy services, allowing for more effective use of the energy infrastructure already in place. In addition, there will clearly be new alliances between utilities and telecommunication companies—witness already PG&E's agreement with TCI and Microsoft. Advanced information management systems will be needed by power providers to allow real-time information on prices, loads and power conditions to flow between providers and consumers. Indeed, there is already a market emerging for these systems and services. This exciting market trend could enable concepts like green pricing, smart billing and load aggregation to flourish and hasten the introduction of sustainable energy technologies for things like efficiency and renewables.

And here I should say that we at DOE Office of Utility Technologies really do see an inevitable transition to a future that will be largely dependent on renewable energy sources. Nonetheless, we also recognize that more traditional energy sources, especially fossil fuels, will be around for quite a while, and that the transition is going to be a long one, taking between 50 and 100 years. But we do feel that, over time, fossil fuels will peak out and renewables will become the dominant energy source. In any event, the kind of system we end up with will be shaped by the sort of discussions going on here today. All of the changes coming in the utility sector make sense; the only problem has been, how do you get the information needed to operate such a system effectively? As markets develop and the utility sector evolves, the application of reliable information technologies will be essential in solving this quandary. Two-way communication and real-time information flows have to increase for power markets to work effectively. It is important that those of you with information systems know-how participate actively in discussions on the future of electric power provision. I challenge you to participate more in the policy debates that are occurring so that decisions can be based on sound technical information. Your contributions and perspectives are going to be very important to a successful transition to a more efficient, competitive and sustainable energy future.

Mary Anne Scott

Program Manager for Information Infrastructure, Technology and Applications,
Mathematics, Information and Computational Sciences Division
Office of Computational and Technology Research,
U.S. Department of Energy

As the old saying goes, "The more things change, the more they stay the same." Things are certainly changing very rapidly for the electric utility industry, but is anything staying the same? Well, one of the things that's always the same in this sort of process is that there are people of vision who can see beyond the immediate chaos and identify the opportunities that change presents. My challenge to you today is to do just that—look beyond all the uncertainty and find something that is better for all of us. You have a real opportunity today to have an impact on what happens in the future. It is my hope that we can find creative ways to benefit all of the stakeholders in this process.

Introductory remarks:

Steve Rivkin

Attorney; Washington, D.C.

It's a great pleasure to join today's inquiry into the information needs of a restructured electricity industry. As a minority of one—the only brown-eyed inside-the-Beltway telecommunications lawyer at this multi-disciplinary gathering of academics and energy intellectuals—I feel right at home here in Berkeley.

Since Chris Marnay and Frank Olken of LBNL have done a superb job organizing the agenda and lining up the speakers and participants, there's been no need for heavy lifting from back East. So, as co-chair, I get to concentrate on the fun stuff, which for me naturally centers on the implications of electricity restructuring on telecommunications and information markets—a subject which at least some of our speakers will touch on today.

Until recently, both industries typically paid slight heed to potential synergies between electricity and telecommunications, but all that has changed. Novel affinities seem to abound—not just in the physics (whereby the photons in fiberoptic networks and electrons in power wires don't kill each other off but can harmlessly interact)—but also in multiple, significant economic interdependencies, which could be critical to the future of both industries.

In the first place, it's fundamental that electricity restructuring will depend, in no small part, on access to an advanced telecommunications infrastructure, which, sooner or later, will be state-of-the art, universal broadband networks—facilities that aren't yet built. At hand, of course, are many useful and quite nifty, low investment expedients, both low-tech and high-tech—radio, satellite, cellular, even power-line carrier systems—some of which might provide useful platforms on which to project competitive and restructured electricity markets out to the ultimate consumer.

But over the long-run, I have little doubt the momentum will be unstoppable toward utilizing state-of-the-art telecommunications infrastructure as such facilities become available. Inevitably, the entity that does not use them will lose out to those that do.

And it only follows that, by the same token, utilities' needs for advanced, universal information infrastructure will be so focused and so financially significant as to drive development of that infrastructure—making the utility itself a leading actor in bringing infrastructure into being.

Synergy that was once merely theoretical could thus become the centrally important two-way street along which both advanced, accessible, universal telecommunications come into being and competitive energy markets flourish. By anticipating this trend, regulators can gain new leverage on trying to hammer out workable schemes for retail access; there may be no way to plan a state's electricity future without also envisaging the future of its telecommunications—which these same state regulators oversee, and vice versa.

So, at the very least, the customary dichotomies in procedures, personnel, task groups, and so on, by which state commissions relate to both industries separately, may have to be modified. A need for suitable and effective "cross-industry" collaborative mechanisms should catch the attention of state regulators—a possibility I hope our discussions today will help illuminate by suggesting specific ways where a cross-industry approach may be useful.

But the true value of recognizing the interdependence of these locally regulated markets may well lie in uncovering specific new solutions to specific problems. Here are just a few possibilities our presentations could address today, where I think a two-track approach integrating both electricity and telecommunications policies could yield big dividends:

1. How can regulators assure universal service, a bugaboo of both electric and telecommunications industries as they restructure, by which many residential consumers are at risk of being shafted twice?
2. How can integrated resource planning be maintained and enhanced, when end users of both gas and electricity are linked to sellers via telecommunications, and fuel-switching can be facilitated at the point of consumption?
3. Can distributed generation and on-site storage of electricity be effectively controlled and dynamically priced via telecommunications?
4. Are there significant cross-efficiencies and savings possible through joint ventures among utilities—gas, electric, and telecommunications—benefiting both shareholders and ratepayers by sharing personnel and capital assets? Can realignments be promoted and managed so as to protect jobs of utility workers by expanding services and making work more productive?
5. Will improved telecommunications and information infrastructure permit more effective continuity of service and disaster recovery—an issue of special significance here in California?
6. Can energy-saving practices for telecommuting and distance-learning be significantly facilitated by utilities' ability to deliver both higher quality energy and higher quality information to the residence?
7. Can consumer access to advanced telecommunications create wide markets for buying and selling "green" energy? Can such markets become economically significant simply because telecommunications and computers enable them to respond efficiently to well-informed consumers?

The potential ramifications of coordinating energy and telecommunications policy development race the imagination. Not all of these ramifications may be benign, of course, and concerns for personal privacy and computer fraud must top any list. Also, the antitrust lawyer in me worries whether new affinities between energy and telecommunications could create excessive concentrations of economic power, enabling local insiders to use technology to foreclose outsider competition. Nevertheless, since the antitrust laws are basically tools to promote rather than retard efficiency, I wouldn't want to paint any gloomy pictures, at least not for now.

Rather, making money by providing reliable services that people need is what regulated utilities are all about. As "businesses affected with a public interest," the sun has yet to set on either electricity or telecommunications, despite efforts to deregulate and to introduce competition into particular market segments. At some level, regulatory "compacts" are bound to continue, even to be refreshed. Moreover, having to live with the undoubted pain of "stranded costs" need not stifle creative thought, rather, fusions and diversifications that might enable new markets and services to emerge should be high on the list of practical and creative expedients that can facilitate, moderate, and stabilize change.

Far out? Certainly at 9:00 A.M. today I don't want to loft us into any such orbits, not yet. But I do want to raise these possibilities to suggest that our conversations could lead to cascading new perspectives and solutions, as traditional walls between energy and telecommunications—real and perceived—start to fall away.

II. Regulatory Setting

Moderator:

Carl Blumstein
University of California Energy Institute

Speakers:

Jeff Dasovich
California Public Utilities Commission
"A CPUC Perspective"

While we tend to look at this industry as special and unique, it's important to realize that what we face today is not a question about what electricity will do for informatics and telecommunications, but how information technology will change the electric power industry. Just talk to the folks in banking, for example, and you will see that it's telecommunications which has turned so many industries on their heads, not the other way around. Yet, unlike like a lot of other industries that have gone topsy-turvy during the telecommunications revolution, electricity has been somewhat sheltered due to its regulated status. This is about to change. The electric power industry will be rattled by telecommunications technology.

In addition to technological change, there will also be more reliance on markets in the future. This does not mean, however, that Commission President Daniel Fessler will be moving out of his office and President Adam Smith will be moving in. Reliance on markets need not imply a slavish bowing down to the temple of the almighty market. Market forces will be used as a tool, and one that will be increasingly turned to, but not to the exclusion of all other factors. Another powerful tool is that of example. I urge you all to look at what has happened in telecommunications and natural gas. These are the models to look at when considering regulatory reform and market- based change. And too, I urge you to speak to as many leaders in the computing industry as possible. These people understand what it means to be in a fiercely competitive environment—the sort of environment the electric power industry is bound to become.

As for the types of information that will be important in a restructured electric power market, I see three: informatics coordination, information, and accounting. By informatics coordination, I mean the coordination of large plants and resources—this is something I think the industry does well already. As for information and accounting, this is where new metering technologies will be essential. The question here is how best to proceed on the information side, and—more importantly—who pays? Answering these questions will be difficult, but the key is to rely on the market when and where possible.

John Chandley

California Energy Commission

"The Western Power Exchange: A CEC Perspective"

In compliance with the CPUC's vision for a restructured electric power market, the three investor-owned utilities have come together to form what is known as the Western Power Exchange (WEPEX). What I am going to do is to describe WEPEX for those of you who may be unfamiliar with its emerging structure, and then talk about some of the problems that those of us who have been involved in the formation of WEPEX are having. These problems may be areas of possible future research.

The structure of the market will follow along what is outlined in Figure 1 (see Appendix A). In Figure 1 you have two different types of transaction taking place. The first type encompasses all bilateral deals taking place outside of the pool structure. For these contracts, the independent system operator (ISO) is responsible only for scheduling dispatch. The second transaction type includes all bid-in transactions at the power pool—Power Exchange (PX). These transactions will be assembled according to some merit order and then fed to the ISO. The rub occurs in the interaction between the two transaction types. This is one of the issues I want to address today.

Initially, however, it is the problem of market power that regulators will be most concerned with. Market power is a multifaceted problem which is very difficult to solve. It is the piece of the WEPEX puzzle that has yet to be solved. The difficulty lies in the fact that there is no agreement about how to attack the problem or even how to define the problem. Should we use modeling or not? Do we look to historical experience or not? To start, however, we must recognize that there are three basic types of market power:

1. vertical market power
2. horizontal market power
3. locational market power

The first type, vertical market power, is solved for by breaking up the generation, transmission and distribution functions of a single entity, and introducing competition in generation while placing the control of transmission in the hands of an ISO. Horizontal market power is trickier to solve for. If you look at who owns all the generators, a large proportion is held by the investor-owned utilities (IOUs). Some are owned by municipal utilities and some by independent power producers (IPPs), but many of the IPPs are under contract to the IOUs. So there is a question of horizontal concentration of generation. The CPUC has recommended to the three IOUs that they consider divesting or spinning off up to 50% of their fossil generation. This is one possible solution, but we are going to need some help on this issue. It's not clear how the issue of horizontal power will be resolved.

Yet, it must be resolved before the Federal Energy Regulatory Commission (FERC) will sign off on competition in California. I will address the third type of market power, locational power, in a little bit.

I want to turn now to the issue of the ISO. There are a number of stumbling blocks lying in the way of a fully operational ISO. I can summarize the problems as:

- How do we solve the dispatch problem?
- Stumbling over the "philosophical" problems: least cost dispatch vs. solving for congestion at the least cost.
- Locational pricing: How many zones make sense?

The first problem is that of dispatch. Shmuel Oren will be addressing this, but the questions include: Can the modeling programs we have now handle the sheer volume of bids we will be getting in the new system? Will there be more than one answer to dispatch in this situation? If so, how will the ISO justify a given decision? The next problem has been described as a philosophical problem, and it has to do with the distinction that is being made between a least-cost dispatch and solving for congestion at least cost. The argument that's being made within WEPEX is that these are two different questions. Some claim that solving in a least-cost manner for congestion resulting from the inherent constraints of the transmission system does not mean providing for a least-cost dispatch. We need to have this issue clearly articulated and explained. Are these different issues or is there overlap? If so, how much and what does this mean for dispatch?

As for the issue of locational pricing, basically what this means is that we are going to recognize that there are, in fact, individual markets within the state. These markets are defined by the transmission constraints of the current system. If you can't get all the power you want into a given area, you have to recognize that the price for power in that area will be higher. We are going to recognize that by creating a series of load-pricing zones. One attempt at setting these zones can be seen in Figure 2. The question is, how many zones do we need, and have we modeled them correctly? If not, how do we redraw the zones and when? Can we redraw the zones once competition has begun? We need assistance here.

Finally, once you get into locational pricing, you get into the issue of locational market power. The question becomes, who owns generation in and around the transmission restricted areas? If there are, in fact, defined geographic markets, then there are opportunities for exercising market power within them. We need assistance here as well.

Ali F. Vojdani
Electric Power Research Institute
"FERC Transmission Services Information Network Requirements"

The Federal Energy Regulatory Commission (FERC), recognizing the centrality of open transmission to real competition, has mandated that transmission must be open to all comers. FERC has endorsed EPRI's facilitation of an industry working group to design a nation-wide real-time information network (RIN) for communication of transmission service information. This work, done in conjunction with the North American Electric Reliability Council (NERC) is expected to result in FERC-mandated requirements of implementation of the RIN.

The information must be available to all users equally. It's evident that the transmission system information network (TSIN), as it's known, must support a range of basic merchant transactions like service requests, confirmation of sale, acknowledgment of transactions, and the like. It's also clear that the TSIN will be an evolving entity. We, along with those we've worked with in industry, have stressed this point to FERC. Transmission information needs are not well understood now, and they will continue to evolve well after the FERC's final ruling.

What can be said about the TSIN, though, is that it must be:

- open: i.e., meets the goals of nondiscriminatory access;
- "seamless": i.e., a single virtual information system;
- customer-driven: i.e., workable desktop applications that are secure and reliable;
- extensible: i.e., can continue to build indefinitely without scrapping prior investments;
- flexible: i.e., providers and customers must have maximum flexibility in selecting systems and applications;
- affordable.

In terms of performance, the TSIN will have to have:

- a node server response time of at least 8,000 bits/sec for the average customer;
- network bandwidth and server CPU performance to support node response time;
- availability at least 98% (downtime less than 7 days/year);
- backed up data no older than 30 seconds;
- recovery from spurious failure within 30 minutes;
- long-term data backup;
- catastrophic failure recovery within 24 hours.

The implementation of TSIN will almost certainly have to be done in at least two phases. The first phase would rely heavily on existing Internet technologies. In the second phase newer links and technologies could be tried, and needs identified in phase one would be targeted. In addition, acceptable downtime and recovery time would be shortened.

For more information on this subject please visit our Web site at: *http://www.epri.com*

III. Electricity Markets

Moderator :
Joseph H. Eto
Ernest Orlando Lawrence Berkeley National Laboratory

Speakers:
Jim Bushnell
University of California Energy Institute
"New Market Fundamentals"

I want to focus in on one aspect of information technologies, and that is *consumer* information technologies. I will present three reasons why we need consumer-oriented technologies in order to really capture the full potential benefits of the restructuring process.

First, it's important to note that restructuring will not save money in the short run, only move it around. The real potential benefits of restructuring will be found in the long-run with better risk management, product development, and better communication of customer preferences. But without better consumer-information technologies, it will be very difficult for these long term benefits to either be realized or flow to consumers.

What kind of technologies am I talking about? Essentially what will be needed will include advanced metering technologies, some sort of load control capabilities—especially if we want people to do fancy things with their appliances, like automatic load shifting—and increased communications and data-management capabilities generally.

There are three areas in which consumer information technologies will play an important role in trying to capture the potential benefits of restructuring. These areas are

1. capacity planning and investment
2. market power in energy markets
3. market power in grid services markets

The traditional approach to capacity planning and investment was to simply make sure everyone had "enough" power and then to spread the costs around in some fashion. There are, of course, "fancier" approaches to capacity planning, including peak load pricing, capacity payments and, most recently, PURPA auctions. In the competitive vision—to the extent that it has been articulated—"enough" power is what you're willing to pay for. How would market-driven capacity investment work? In the full-blown market version, generators are paid only for the energy that they provide. These generators would therefore plan and build whatever capacity they deemed necessary and then pay for their fixed costs out of operating profits. For this sort of system to work however, demand must set the price in peak hours. In the UK, however, we know that demand is not responsive to prices. In the UK, a capacity payment is paid to generators based on what is called the Loss of Load Probability (LOLP). The LOLP is very sensitive to capacity availability, and suppliers have learned that they can earn large profits by reducing available capacity. Generators in Britain earned a full 20% of their revenue from capacity payments in 1994-1995. The point here is that we want to have customers make a choice about their need for capacity and have a system where their choices are relayed back to the producers. In this way, consumer demand, not government policy, will guide capacity investment.

In regard to market power, John Chandley nicely made the point that there is currently a move afoot to get utilities to divest some share of their generation portfolio. This is a focus on the concentration of supply. Concentration, however, is only half the story. The ability of demand to respond to price is also very important. A telling illustration of this point is found in the Lerner Index, which is what economists typically use to measure the severity of market power.

The Lerner Index is simply the relative difference between price and marginal cost in a market. If a market is fully competitive, price will equal marginal cost. In one of the classic models of an oligopolistic market, the symmetric Cournot model, however, the Lerner Index equals 1 over the negative number of firms, times the elasticity of demand. In other words, the elasticity of demand is equally as important as the number of firms in measuring market power. Looking at supplier concentrations alone, then, can be a misleading indicator of market power. Also, this equation makes clear that if policymakers can take steps to increase the elasticity of demand, then this is something that would have a lot of "bang" for the policy "buck" from a market power perspective. Raising elasticity will reduce market power.

Now, in terms of demand technologies and grid services, some ancillary services—such as voltage support—are local in nature and are therefore vulnerable to market power abuse. Demand-side alternatives may be the only way to introduce meaningful competition into these markets.

In closing then, it's important to emphasize again that the true benefits from restructuring will come in the mid to long term, and that the full realization of these benefits will depend on the adoption of consumer-oriented energy information technologies.

Stephen Rassenti
Economic Science Laboratory, University of Arizona
"Using Controlled Experiments to Test and Design Market Rules for Trading Electric Power"

The emerging markets for electric power that we are talking about here today will be inextricably bound up in the behavior of the principals acting in these new markets. When you create a set of rules where people have incentives to maximize their own profit, sometimes these rule sets and their environments do not work the way one might expect them to. We have seen this over and over again in the experiments we have devised over the years at the Economic Science Laboratory. The question is, can we design experiments in this particular endeavor—that of restructuring electric power markets—which will allow us to create mechanisms that will perform efficiently, even though individuals will have incentives to game these mechanisms.

To give you an idea of what goes on at the Economic Sciences Laboratory, I want to present the example of a simulated gas network. In this experiment we ran two scenarios for a gas market:

1. bilateral bargaining followed by a sealed bid auction for transportation,
2. location-specific bids with a smart auction.

We motivated subjects by paying them a flat rate just for showing up and then we paid them whatever their earnings may have been in the experiment. It's not unusual in our experiments to see some students leave with hundreds of dollars and others to leave with nothing but their show-up fee. In the experimental environment, we measure efficiency by looking at how much money people take home. In the gas experiment, as in other similar experiments, we have seen that there are in fact ways to construct systems that will operate at higher efficiency levels. For example, a system where people blind-bid into a centrally coordinated one-shot market is likely to be less efficient than a system that allows people to get feedback until some final closing bell rings. In the latter system, individuals are able to constantly readjust their bids in response to the most recent solution to a centrally solved surplus minimizing linear program.

In designing experiments, it is important to choose the simplest environment you can to attack the question you are concerned with. When we began our experiments into electric power markets, we began with some very simple networks, including a three-node radial market. Yet with these simple networks we can address a number of important questions, including:

- Do spot market trading rules have large consequences on market allocations? prices? shares of surplus?

- Who gets the congestion rents when a transmission line is constrained?
- Do active buyers affect the spot market price and surplus allocation?

Results from our initial experiments indicate that:

- subtle changes in auction rules can affect efficiency;
- transmission owners cannot count on congestion rents if they are not active in the marketplace;
- interruptible capacity can dramatically alter market prices;
- buyers have strong incentives to interrupt strategically.

In sum, experimental economics shows us that institutional rules matter in markets. It is relatively easy to tinker with rules in the experimental environment, and so it is a good way to learn a lot about a range of alternative trading systems quickly and without costly field experiments.

James T. Turnure
U.S. Environmental Protection Agency
"Environmental Information in Power Markets: Design Issues"

I need to begin by reiterating that the EPA is in favor of electric competition, and we do think it will bring environmental benefits, mainly in the long-run. We've been trying to get this message out and to let people know that, in general, the EPA is increasingly enamored of market-based solutions.

In contemplating the environmental impacts of a restructured electric power market, however, it is important to do as much quantitative analysis as possible. In seeking to model market situations and the environment, several major design issues come into play. For example, if we assume that our goal is the efficient inclusion of environmental costs in a spot market, we have a number of design issues confronting us right off the bat, including:

- how many pollutants do we want to cover?
- what media are affected (i.e., air, water, soil)?
- is there geographic variation?
- is there temporal variation?
- model for decision behavior or technical accuracy?

Finally in implementing a given model, we can think in terms of two "extremes." Is it important to consider real-time, location-sensitive, specific emissions, or is it better to look at average, pool-wide values by fuel type or by technology type?

In terms of sorts of data we have or are generating at EPA, there is a great deal, all of which is available for use. EPA lives on data and, while it is a mess in many cases, it does include:

- information from continuous emissions monitors (CEMs);
- extensive engineering data for technology types;
- media-specific propagation models;
- epidemiological, ecosystem impact studies;
- the "A-12" country-specific impact database.

To the extent that people are interested in technology related, real-time data, however, it is the CEMs that hold the greatest potential. CEMs are relatively new and are required under the Clean Air Act. CEMs measure SO_2, NO_x and CO_2 in up to 15-second intervals. They can measure up to the pound or less. Electronic reporting is now becoming standardized and automated quality control is quickly evolving. Unfortunately, the current lag time in final reporting of emissions using CEMs is 15 months. This is because there are multiple tests for anomalies in the data and for quality control and review in general.

The problem with CEMs relative to spot markets is that, assuming their use in real-time conditions, CEM data may actually cause price spikes. This is because the emissions data itself varies considerably. If this data is then incorporated in setting a spot price, someone who receives a shipment of particularly high sulfur coal one month and burns it, would spike emissions and could spike price. Here it is important to note that under the Clean Air Act, emissions are monitored on a total tons-per-year basis, and so there is no incentive to have a consistent fuel quality month to month or week to week, assuming that the yearly target is met.

Smoothed averages may assist with this problem, but in any event, integration with other policies is critical to avoid counter-productive outcomes. Quantitative analysis and experimental or modular implementation is also advisable.

IV. KEYNOTE SPEAKER

Dr. Daniel Fessler
President, California Public Utilities Commission

I wish to give you a brief sketch of what we at the California Public Utilities Commission are attempting in restructuring the electric service industry and to tell you where I think we are in that process. In addition, I will say a few words about the vital role that information is playing in restructuring.

In my brief period in public life, the electric services industry in the State of California has gone into a state of what I think we will call "semi-crisis" for a very simple reason: 'we can't afford it.' When Dwight Eisenhower left the Presidency he warned the American people against what he called the 'insidious creep of a military-industrial complex.' Although I think we would have been loathe to admit it until recently, somehow, in California, we did not pay heed to that warning. And so, in 1991-92 as the USSR began to transmute itself, a dramatic change was made with regard to the level of defense expenditures that the federal government was willing to support. With that coincided a move of the California economy into what was a cyclical recession that was beginning to sweep into the West from the eastern part of the U.S. The combination of these two events has lead to a major sea-change in our economy.

It is estimated that in the period of time that I have been at the PUC, the State of California has lost 800,000 jobs. That is the equivalent of the entire economy of our neighboring state of Arizona. More importantly, we are now discovering that we are not rebuilding those jobs at a rate that suggests that this was a cyclical event. We are gaining back by the hundreds jobs that we lost by the thousands. Moreover, these new jobs are of a different kind and a different quality.

In the near term, these changes have put a tremendous emphasis on the cost of virtually every aspect of daily life in the State of California. It has caused us to recognize that things, which were tolerable in a former era, are today perhaps no longer sustainable. So it is with electricity. We have rates for electricity in California that still hover about 50% above the national average. Worse yet, we are surrounded by states whose rates for electricity are below the national average and who are more than happy to point to California's costly electricity as evidence that the California economy is no longer competitive. Electricity is by no means our only problem. But it is a problem within the purview of those of us working at the California Public Utilities Commission.

So I want you to understand that when we look at the electric services industry, we begin with the premise that our basic problem is one of cost. It is true that the success we have had in promoting energy efficiency means that for the average ratepayer in domestic consumption circumstances, the average bill in California hovers slightly below the national average. But ratepayers who, by dint of their occupations in industry, commerce and agriculture, are condemned to be large consumers of electricity, get little solace from that fact. It is these large consumers who are the leading edge of the phalanx of complaining parties suggesting that something must be done.

Combine that economic set of motivators with a study we completed at the Public Utilities Commission which showed that the way in which we had historically regulated the electric services industry no longer bore any relation to the industry as it had evolved. Our normative assumptions about regulation were essentially frozen in time. They concentrated on dealing with secure, vertically integrated monopolies. Yet on the generation side of the industry, this model was already no longer applicable. In addition, as the single largest importer of energy in North America, it became clear that California was positioned awkwardly within a market which was visible, but not well understood by decision-makers and not well captured in the mind of the public.

When all of these factors were considered, two ideas began to coalesce. First, as a group of 32 million ratepayers, Californians were not doing all that well. Second, as a group of 32 million consumers, Californians might do better. By recognizing that we were the integral consuming part of the energy markets in the western United States and by seeking to foster competition already underway in generation, it became clear that we might evolve a set of institutions that would serve our people better. That is the entire thrust of the efforts that the California Public Utilities Commission is conducting.

In pursuing this vision, we at the Public Utilities Commission have developed quite an active "foreign policy." Our foreign policy brings us together with the federal government on numerous occasions. This has been a rewarding challenge, as we have articulated a theory of cooperative federalism as replacing notions of confrontation over states rights versus the rights of the national government. With regard to the Federal Energy Regulatory Commission (FERC), the ultimate proof of the success of this strategy will arise with the filings we intend to make at the end of April with regard to the creation of the power exchange and the independent system operator. I am encouraged by the statements of my colleagues at the FERC that we will be amply rewarded for both our trust and our patience.

So, where are we with regard to some of the basic discoveries that I'd like to leave you with? Well one is that the classical debate over federalism turns out to be grossly ill conceived given both the opportunities and the challenges of the new world in which California finds itself. The world of energy in the northern and western part of North America is regional in its present complexity and assured future and absolutely trans-national in character. We are now part of a market that extends from British Columbia and Alberta to the Mexican states of Baja and Sonora. The electric grid we in California are tied into extends out to these areas. Hence the market that we are talking about is congruent with no single governmental entity on the face of the earth. This means that seeking to resolve issues pertaining to this market in either Sacramento or Washington, D.C., will be inadequate. This is a major challenge for my successors and for you.

Yet if there is no governmental entity that can cope with this extended region, that is all the more reason to let markets solve as many of the problems of electric power provision as possible. Markets and consumer decisions can cross the artificial frontiers that we call state and national boundaries.

Now, as to the architecture of our decision. On December 20, the California Public Utilities Commission identified those market institutions that we have found to be congruent with our perception of what is best for the people of the State of California. In our view, the world of the vertically integrated monopoly is now at an end; in fact, it has been at an end for some time. With regard to generation, we believe that it is in the public interest to strive to make the market for generation even more competitive than it already is. With regard to transmission, we believe transmission is a natural monopoly, but that the monopoly is no longer sensibly congruent with the service territory of a historic utility. We propose the creation of a statewide independent system operator which will manage but not own the apparatus for transmission.

By January 1, 1998, then, three market institutions will be in place: the power exchange, the independent system operator, and the concept of direct access contracts. This will be the basic market structure. I believe that if this structure works in California, the regional implications of this structure will not be lost on the states and provinces around us.

What about information? Information is the optic nerve of this new vision. It is my belief that electricity is a service that has gained societal recognition as a necessity. Electricity is not a luxury in life. As such, electricity will merit strong societal interest in the terms upon which it is made available. In moving to reliance on competitive mechanisms, it is my hope and belief that society has not surrendered the intrinsic recognition of the necessary quality of electricity, but has decided that with regard to one discrete aspect of electricity—generation—society is better served by market mechanisms. Competition is not, however, the choice of a society disinterested in issues of efficiency, the environment, or the plight of disadvantaged individuals. If society is to take into account these issues, then it will be up to both buyers and sellers in this new market to react intelligently. They cannot react intelligently in the absence of information.

We believe, then, that the transparency of the new system is vital to its success. We believe that if the clearing price on the power exchange is notorious, participants will react by making intelligent use of information, which, under the old regulatory order, was at best obfuscated.

Finally, for consumers we have done something quite remarkable and quite unnoticed. During the period of time that consumers will hold utilities harmless for investments made under a different regulatory arrangement, those utilities will sell their generation into the power exchange—making it a deep market on the day it comes into existence—and they will buy their needs for all customers on the power exchange. The utilities will then deliver the power they have purchased to their customers without one iota of markup. And so the ability to reach the wholesale market as a consumer will become the right of every ratepayer in any utility jurisdictional to the California Public Utilities Commission. With that information notorious—showing up on every utility bill—the consumer will learn that there is a basic election to be made: to be billed under an average rate, or have one's pattern of use to be billed in real time. To make this choice, and to consider the prospect of hedging risk by contracting for differences, consumers will need information in ways in which you are beginning to explore.

This is a basic sketch of the world as we would have it. It is not a complete picture. There are many other issues. What we have done is start nothing. The change has come from without. Had we done nothing, the changes that are transforming this industry would continue. We have merely sought to influence the process on behalf of the public interest.

V. Informatics Requirements

Moderator:

Stewart Loken
Ernest Orlando Lawrence Berkeley National Laboratory

Speakers:

Shmuel Oren
University of California, Berkeley
"Computational Aspects of Electric Systems Operation and Restructuring"

I want to talk about some of the algorithmic computation that must go on in calculating optimum dispatch. This is the process of minimizing generation cost subject to generation-limit constraints, demand constraints, power flow constraints, thermal line limits, voltage line limits, and system security constraints. In solving for all of that, we should end up with some marginal cost of generation, which will in turn determine spot prices.

All of this is really predicated on the commitment of units. As units cannot be committed on a five-minute notice, you have to solve in advance a unit commitment problem. This is a complex problem involving the accounting of multiple inter-temporal dependencies. Utilities have traditionally tried to solve this problem with what is termed the Lagrangian relaxation of the unit commitment problem. The question is, how do the mathematical tools used for solving these problems relate to a competitive electric power industry?

Some people have suggested that the tools we currently use are sufficient to optimize dispatch in a competitive environment. In fact, in the United Kingdom, just such an approach has been taken. The British are using an algorithm that was originally designed as a central planning tool, but is now being used by the grid operator. All of the bad prices and constraints go into this algorithm, unit commitment takes place, and then there are a number of ways to compensate the availability. The key point here is that since unit commitment affects spot price, you have to be as close to an optimal unit commitment as possible.

Some of the issues concerning the implementation of scheduling and dispatch algorithms include:

- gaming of cost and constraint information (market power);
- self-commitment vs. central unit commitment (recovery of fixed costs);
- solution degeneracy (i.e., many equally good solutions but profits sensitive to program parameters);
- post dispatch prices for price-based resources vs. integrated dispatch;
- ex-post vs. ex-ante pricing (efficiency);

- integrated demand-side resources in scheduling and dispatch (efficiency);
- centralized vs. distributed implementation of algorithms (central vs. market solutions).

Here it is important to take special note of item three. One of the dilemmas for system designers in a competitive marketplace is that while there may in fact be many equally good solutions to solving the problem of overall dispatch efficiency, each solution will have different sets of winners and losers. How and on what basis should the system operator make a decision about a given solution then? This is a very sticky issue.

In regard to the last issue, it is possible and desirable to rely on the market as much as possible. A centralized approach really defeats the point of restructuring. If the system is constructed with not a one-time but rather a sequential auction done 24 hours in advance with 15- or 30-minute intervals in four or five cycles, then bidders will have a chance to respond to commitments and iterate on that. This would be a market implementation of these algorithms, relying more on information availability and less on central planning.

Ultimately then, the trends and potential changes that will affect computational requirements will include:

- increases in the number of resources scheduled and dispatched (QFs, IPPs, gas turbines, curtailable loads);
- distributed resources (virtual utility);
- demand side bidding;
- increased frequency of market interaction (i.e., hourly auctions);
- moves to multi-stage auctions (i.e., FCC type or load slice auction);
- the parallelization and distributed implementation of scheduling and dispatch.

Pravin Varaiya
University of California, Berkeley
"Comparison of Independent System Operator Structures"

As the foregoing presentation illustrates, it is not possible to separate the question of information requirements from the issue of the structure of the independent system operator. I want to address the issue of what sort of information might be needed by discussing two ISO structures. One roughly corresponds to the California proposal, which is in turn based on the British system. The second is a sort of truncated ISO structure.

The current proposed California ISO structure really reminds me of work done in the 1920s and 1930s that led to the creation of Gosplan, the system that the Soviets used to replace the market, now made obsolete by such a fine central planning tool. Of course as we all know, Gosplan has sort of disappeared and so it's interesting to see it resurfacing now in California in the form of the proposed ISO. I want to talk about a different type of system that could be compared to the Internet, as opposed to a centralized Gosplan.

The current ISO proposal is one where, 24 hours in advance, the ISO/WEPEX will receive supply and demand curves from generators and distributors plus a range of information on constraints. The ISO will then centrally compute some dispatch and ultimately ex post settlement prices will come into play. This type of system:

- requires very extensive private data on costs and benefits;
- reduces commodity and contractual choices available to consumers and generators;
- ignores inter-temporal linkages in production and consumption;
- hinders innovations taking advantage of diversity in consumer preferences and generator technologies that cannot be captured through standard commodities and settlement charges.

Now, when we think of an ISO we can conceive of several areas where the ISO mediates between generators and consumers. These include:

1. Security, voltage stability (in real time)
2. Dispatch and regulation (in real time)
3. Congestion management (day ahead and real time)
4. Ancillary services, e.g., reserves, VAR support (day ahead and real time)
5. Scheduling (day ahead)
6. Creating a spot market, setting locational energy prices, transmission congestion surcharges, regulation charges (ex post)
7. Administering various uplift charges (ex post)
8. Creating, administering and supervising transmission contracts.

Now items 1 and 2 are conducted with an eye towards system security. Items 3-5 cover service quality. Items 6-8 are designed to account for "economic efficiency."

Since ISO functions are costly (resource costs + opportunity costs), it is my contention that ISO design should minimize its functions. This means that not all of the functions spelled out above actually need to be or should be carried out by the ISO. I propose a minimal model. In this model all generators and loads are connected to a single, lossless busbar. Multilateral trades of varying durations are made. For each period t, the ISO is informed 24 hours (and preferably less) in advance of schedules for t. The ISO then checks to see if each trade is feasible. Schedules for t are committed at (t-24). At real time t, the schedule is dispatched, and the ISO monitors each trade. Finally, and in real time, imbalances are corrected by the ISO and charged to defaulting trades.

In this model, the role of the ISO is almost trivial. Its functions are only to verify the feasibility of trades 24 hours ahead, dispatch and monitor trades in real time, and eliminate imbalances and charge commitment violations. The ISO has no data on costs or financial arrangements, and ancillary services may be either privately procured or purchased through the ISO.

In closing then, I present the following comparison of what is more or less the proposed current California ISO structure (MaxISO) with what I have discussed here today (MinISO).

MaxISO	MinISO
Ideal is lowest cost generation	Ideal is open access bus
Transmission constraints dominate in commodity design; other transactions are standardized	All transactions/commodities permitted; transmission constraints are side conditions
Wheeling treated differently	Wheeling like other transactions
Inter-temporal, contingent transactions face extra costs	Inter-temporal, contingent transactions are not penalized
Requires large amounts of private cost- benefit data	Requires no data on cost, benefit
Metering and communication needed	Metering and communication needed
Difficult to accommodate bilateral transactions	Accommodates pooled transactions

Andy Colman, First Pacific Networks
Gerald Harris, Global Business Network
"Scenarios on the Use of Informatics in Electric Utility Restructuring"

We are going to present a set of four scenarios discussing various aspects of informatics and electric utility restructuring. Now some may ask, why scenarios? Well, first, we can't predict the future and thus our mental map needs to be challenged. Second, scenarios can be used to "wind tunnel," or test, existing strategies and develop new strategic options. Finally, scenarios are a useful device to help "learn your way forward."

We put together a scenario with two axes (see Figure 3). The first axis attempts to plot the nature of consumer demand and market structure. This axis has feature-driven at one end and cost-driven at the other. The second axis plots the commercialization of information and communication (I&C) technologies in the utility industry. This axis has slow entry rate at one end and high entry rate at the other. Laid across each other, these two axes create four quadrants.

To start exploring these quadrants or scenarios, imagine yourself in a world where you had a very slow and uneven pace of commercialization of information and communication technologies in the utility sector but had a relatively feature-driven market structure. You would be in the scenario we call "Old World Automation." This is a world of conservative, risk-averse utility managers who believe in cost leadership. It is a world where utilities concentrate on recovering past "prudent" investments. It is a world where I&C technologies are interesting but don't readily translate into basic energy production and supply. It is a world where the most exciting I&C services are in other areas like entertainment, financial services and telephones. In short, it is very like the world we live in today.

Imagine what would happen, however, if I&C technologies began to be rapidly introduced into this environment. Then you would be in the quadrant we call "The New World Order." In this world a transition to a new, cheaper and more flexible electric power base is pushed. In this world the traditional players embrace change. There is also rapid entry of distributed generation, small power technologies and the management and information services to make it all work seamlessly. In the New World Order, customers demand and aggressively mange energy-related information services, and new entrants in the energy services sector target different customer segments. This is the world that many of us clearly want to get to. Some may even assume we are bound to get to it. There are, however, other possibilities.

If, instead of moving toward a high entry rate for I&C technologies we instead find we move to a market structure that is simply increasingly cost driven, we move down to quadrant three, "Back to the Future." Here there are cautious, cost-conscious consumers—what we call the 65% slow adopter—there are stable or declining power costs from traditional sources, and there is aggressive cost-cutting by utilities to reshape the traditional business model. In addition, this scenario is characterized by over-promising and under-performing I&C technology.

The final quadrant in our scenario setup takes us to what we call "Customer Lag." In this situation I&C technology is developing and being pushed into the power sector on the basis of "potential" demand. Here, however, consumers are typically unwilling to pay for special features while still demanding lower cost energy. Nonetheless, a lot of technology is finding small or hot ephemeral markets. Finally, utility managers are not of one mind and are trying a wide range of potential applications.

As may already be clear, this framework of scenarios has many implications for I&C technologies. We see information and communications as having four distinct parts, or networks: the host network, the backbone network, the distribution network, and the customer network. Each of these networks can be thought of analogously in terms of power supply. The host functions as a "generator," the backbone as "transmission," distribution as distribution, and the consumer as end-use sources. Each of these four networks gets slightly different emphasis in the scenarios we have sketched out above. In the "Old World Automation" scenario, significant investment in capital and in process design will go towards the host, backbone and distribution parts of I&C and to the transmission and distribution parts of electric power provision. In the "New World Order" scenario, investment flows towards the host, distribution and consumer part of I&C and the distribution and end-use segments of the power industry. In "Back to the Future," investment concentrates on host and backbone and generation and transmission. Finally, in the "Customer Lag" scenario, investment activity is focused on the host and distribution parts of I&C and the distribution and end-use parts of the electric power industry.

It is not now possible to say into which of the quadrants we are likely to find ourselves in the near future. We hope, however, that in conceptualizing the issue of electric power restructuring and information requirements in this way, we can be better prepared for the range of possibilities and consequences.

VI. UTILITY ACTIVITIES

Moderator:
Steve Rivkin
Attorney; Washington, D.C.

Speakers:
Roger Levy
Levy Associates
"Advanced Systems to Support Operations, Commercial Services, and Competition"

There is a race going on in the marketplace with regard to information systems and advanced metering. Currently, power marketers appear to be in the lead on this issue with energy agents and electric utilities bringing up the rear. Regulators, however, aren't even on the track. What is happening in the marketplace is proceeding well in advance of regulatory activity. This is a clear indication that the market is being driven by the customer

To begin, it is important to summarize two key new rules for utility technology planning.

- Rule one, there is no long term. Utilities have typically used a planning horizon of from 10 to 20 years or longer. That horizon is no longer relevant in today's fast-paced, competitive market—particularly with regard to information and communications technology. With new product cycle times of less than a year, investments should be guided by return on investment and strategic factors—not cost recovery.
- Rule two, act now. "Waiting to see what happens" is the highest risk strategy. Although acting now is perhaps contrary to traditional utility practice, it is essential if only as a defensive mechanism. Substantial portions of many utility markets are already under attack; some have already been lost to the new competitors.

Fundamentally, there are two major differences between what utilities are doing on the one hand and what power marketers, aggregators, and energy agents are doing on the other. For utilities, the driving factor is still cost minimization. For all others, the driving factor is profit maximization. In addition, utilities are still looking at traditional applications like automatic meter reading and distribution automation. In contrast, the "competitors" are looking at a variety of applications that include advanced billing, site aggregation, and value-added services. The basic contrast is that while utilities are still focused on internal systems and operations, the competition is concentrating on customer-focused applications. It is not much of a guess which one will prevail in a competitive market.

The status of the market for customer-oriented energy services and delivery systems can be characterized as follows:

- an almost frantic pace of activity
- new companies, alliances, and ventures announced almost daily
- an orientation toward multiple fuels and multiple services
- multiple communication and metering technologies—no single best solution
- a power shift from local to national accounts
- the emergence of virtual utility service territories.

Overall, systems are expanding functionally and in scope. New offerings address electric, gas, water, waste management, communication, and other services. Systems are also expanding geographically. The electronic interface is being positioned as a mechanism for dynamically restructuring customer accounts to match local retail market opportunities. This expansion is creating a significant power shift. At the local level, customers are finding that aggregation, either through energy agents or associations, allows them to gain negotiating leverage and move into a position where they drive the market. Large national accounts have also discovered that the new energy economics makes good business sense. Savings in the 2-3% range are often enough to motivate a shift to an alternate provider. It is clear to some that many of these large national accounts will increasingly be served by national power providers—not the local utility

Ultimately, contracting for electric power services in the competitive marketplace is likely to promote consumer-oriented structures and virtual utilities without contiguous service areas. This will also lead to complex, networked systems, dynamically linked to financial markets for a variety of energy services. It is obvious that the information infrastructure supporting generation and delivery systems will have to follow suit.

Jack Allen

Pacific Gas and Electric
"Challenges of Implementing an ISO in California."

I will be brief, but I want to run through a few issues regarding the establishment of the independent system operator. How do we take the concept of the ISO and make it work?

Right up front, I think we have to address the issue of cost. Let's begin by looking at the price of the ticket before we set sail. The time to ask about cost is before, not after, you leave the port. The question is how much will setting up an ISO cost, and what are the technical solutions available to us that allow for a faithful but cost-effective implementation of the ISO.

Another issue to be concerned about is that of non-discriminatory pricing. What do we mean by that? If I'm an aggregator or direct access customer, the only way I can be sure I'm getting a fair deal with the ISO is to ensure we have an adequate archiving and documentation system. This is a phenomenal task. What we are really dealing with is not just a few bits of information about the schedules, but what the system conditions were at a given time. And we're talking about at least 24 periods in the day. Currently Edison and PG&E each have about 150-160 schedules per day, and we each have between 100 and 300 changes in those schedules each day. You begin to get a sense of some of the complexities involved.

My message is not that we can't do it, but that we have a very serious challenge in taking the requirements presented to us and make it all work by January 1, 1998. A big piece of this is to try to develop a system that will not only work for technologies today, but which will also have to incorporate technologies not yet developed. We also have to consider the issue of gaming, as Stephen Rassenti mentioned.

In terms of information requirements, there is a tremendous need for a high-volume, high-speed transfer of data between all participants and the ISO. This information will have to include things like reliable metering data and hourly line-loss data. Where possible, we should strive to use off-the-shelf technologies as building blocks for the system. Again, it's not that we can't do this, it's that we must not wait for final answers to get started.

Jack King
Scientific Atlanta
"Utility-Consumer Communications"

I, too, will be brief. We now all finally recognize the fact that competition is really coming to electric power. Utilities are beginning to see that they've got to do something, but most don't know what to do. All are understandably concerned about stranded investment and the prospect of a diminishing revenue stream. Until it's clear that they can recover investments, most utilities are not going to make many or any major investments. They are—not surprisingly—risk averse.

Yet as Philip O'Conner has noted, there are at least eight big lessons utilities can draw from other transforming industries:

1. the system has more capacity than predicted
2. the grid goes from monopoly boundary to exchange network
3. financial depth is essential to weathering the storm
4. marketing skills are key to success
5. cost structures must be reduced
6. competition will penetrate to even the smallest customers
7. technology improvements will be rapid
8. re-organizing through information-communications distinguishes the winners and the losers.

In this eight-lesson list I want to emphasize items five and eight along with the concept of value-added services. The future market structure will be crowded with players. In this environment it is clear that costs must be reduced and value must be added, whether it is perceived value, defined service value or enhanced service. Successful use of telecommunications technology will also be essential to survival in the future. In the past utilities used telecommunications tactically, in the future they will have to use telecommunications strategically. In other words, telecommunications technology will have to be an integral part of what makes a utility competitive.

It is because the revenue stream is shrinking while the number of players is growing that not all companies will be able to make it in the future market. The only way to get more revenue into the system is to increase to the level of value-added services. The analogy here is telephone service. In the telephone service business basic telephone line cost has dropped, yet total telephone revenue has risen. This is because phone companies have added a whole range of new services: call waiting, special calling plans, caller ID and the like.

Fortunately for utilities, the list of opportunities utilizing communications is large. This list includes possible new products and services like, meter reading on demand, outage reporting, special pricing, multi-site billing, and practical home monitoring and automation.

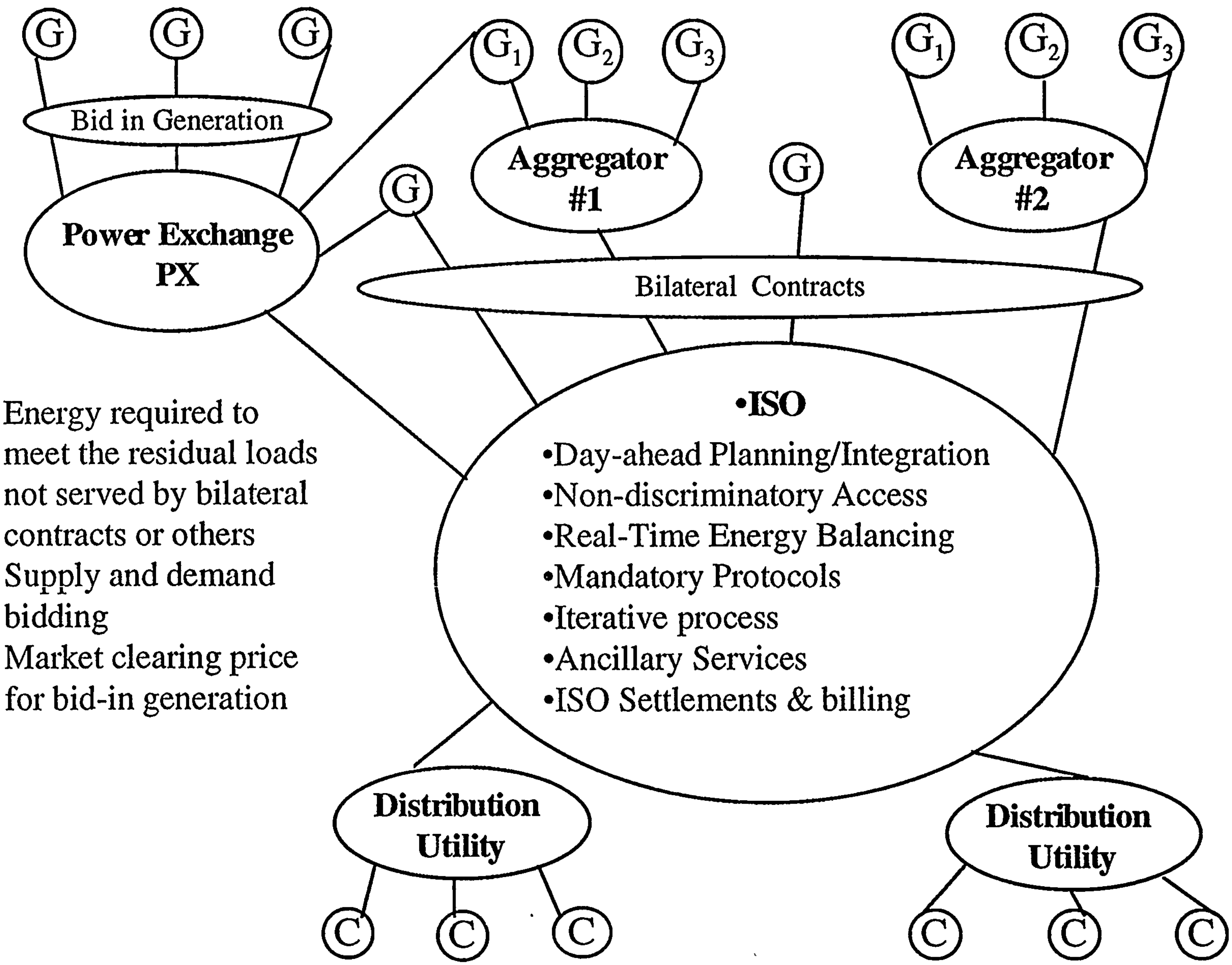
So what will survivors in this new environment look like?

1. They will be low-cost producers or suppliers, or
2. They will be value-added services suppliers, and
3. They will have to have superior customer services.

All of these tasks will be assisted and enhanced by the use of advanced telecommunications.

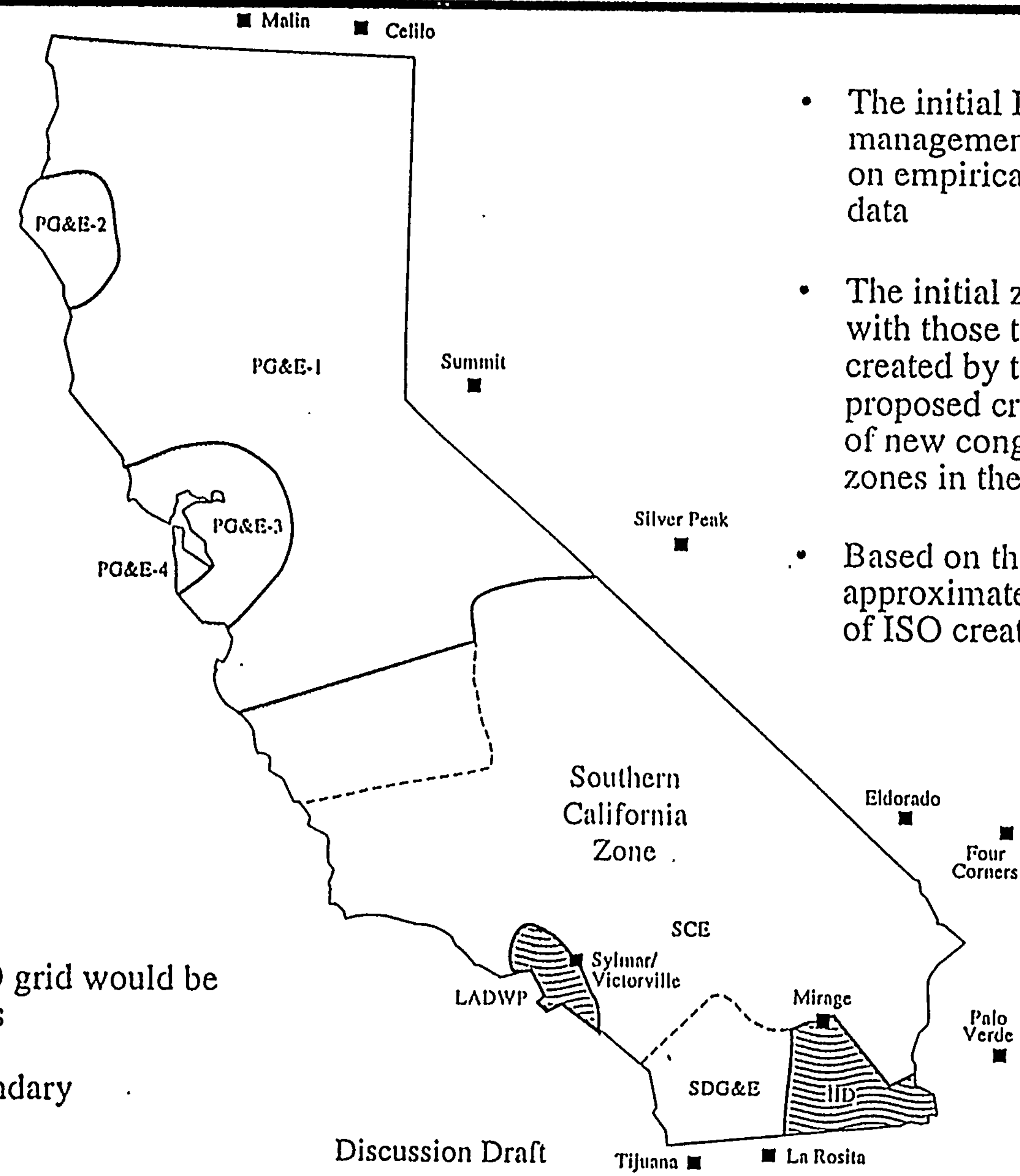
APPENDIX A: FIGURES

Market Structure



- Energy required to meet the residual loads not served by bilateral contracts or others
- Supply and demand bidding
- Market clearing price for bid-in generation

Preliminary Zones for Locational Pricing



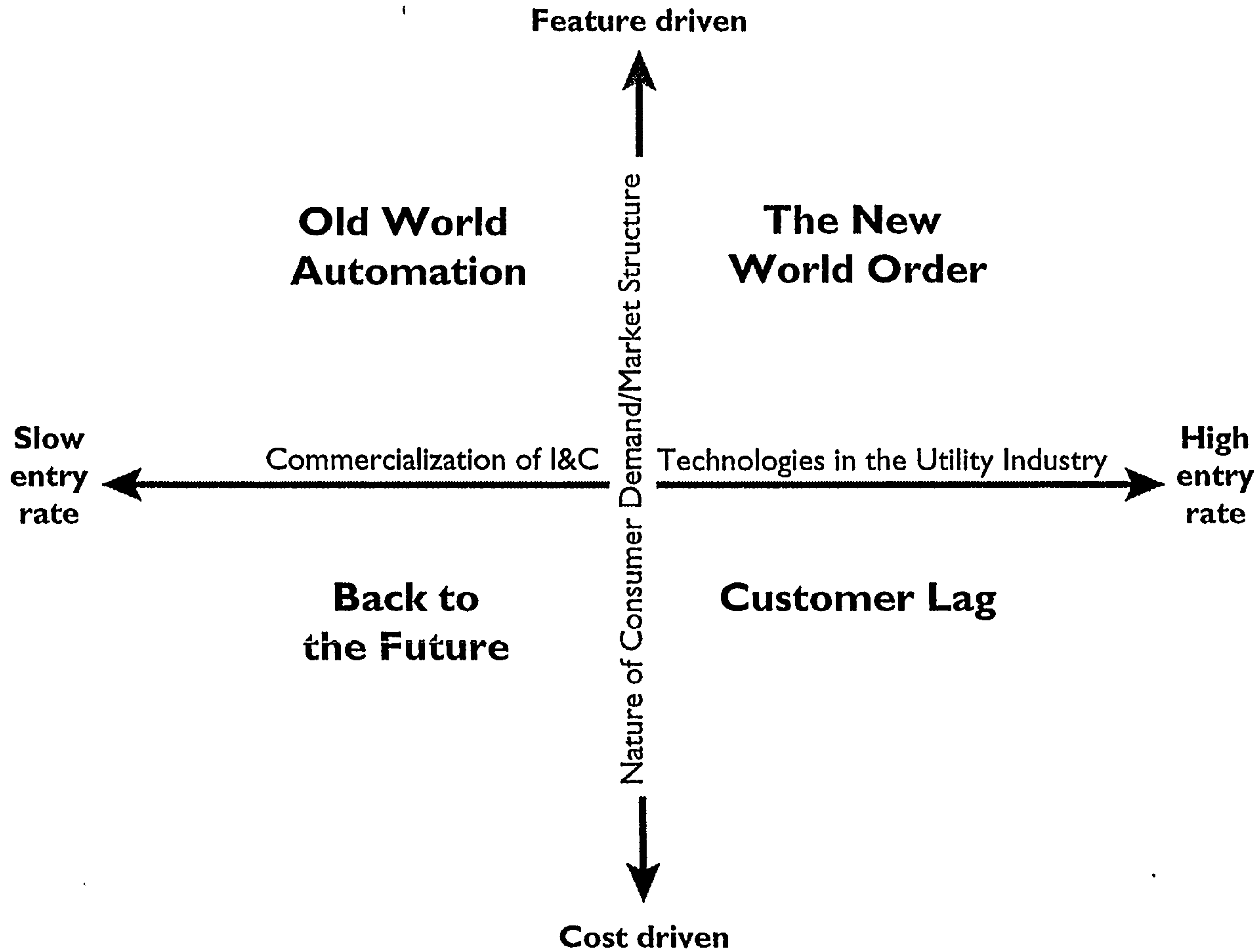
- The initial ISO congestion management zones will be based on empirical, historical congestion data
- The initial zones will be consistent with those that would have been created by the application of the proposed criteria for the creation of new congestion management zones in the future
- Based on this, there will be approximately 5 zones at the time of ISO creation

■ Tie points with non-ISO grid would be additional pricing points

---- Utility service area boundary

Discussion Draft

The Scenarios



APPENDIX B: SPONSORING ORGANIZATIONS

SPONSOR

The Office of Computational and Technology Research (OCTR) provides a focal point in the Office of Energy Research (ER) of the U.S. Department of Energy for long-term computational and technology research. The OCTR manages research in forefront and diverse applied mathematical sciences, high performance computing, communications, and information infrastructure which spans the spectrum of activities from strategic, longer-term, fundamental research to technology research, development, and demonstration. The OCTR links ER's science programs and laboratories to national economic competitiveness by conducting long-term, high-risk industry relevant research and development projects in critical technology areas. The Office provides the technical, analytical, and management direction for development, implementation, and evaluation of long-term research programs which include major involvement in activities such as High Performance Computing and Communications (HPCC), the National Information Infrastructure (NII), the American Textiles Consortium (AMTEX), the Advanced Computation Technology Initiative (ACTI), and the Environmental Technology Partnerships (ETP).

http://www.er.doe.gov/production/octr/octr.html

ORGANIZING INSTITUTIONS

Founded in 1931, the **Ernest Orlando Lawrence Berkeley National Laboratory** is the oldest of the national laboratories. First known as a Mecca for particle physics, Berkeley Lab long ago broadened its focus. Today, the Lab is a multiprogram facility where research in advanced materials, biosciences, energy efficiency, detectors and accelerators focuses on national needs in technology and the environment. Berkeley Lab is located in the Berkeley Hills, next to one of the world's great universities—the University of California at Berkeley. Today, we have some 3,400 employees, of which about 600 are students. Each year, the Lab also hosts more than 2,000 participating guests. Berkeley Lab is managed by the University of California for the U.S. Department of Energy (DOE). Within Berkeley Lab, the **Information and Computing Sciences Division** (ICSD), and the **Energy Analysis Program** (EAP) of the Energy and Environment Division, have taken the lead in issues of information infrastructure and electric power industry restructuring.

http://eande.lbl.gov/EAP/EAP.html
http://www.lbl.gov/ICSD/

The mission of the **University of California Energy Institute** is to foster research and educate students and policy makers on energy issues which are crucial to the future of California, the nation, and the World. The Energy Institute is the only research unit in the U.C. system that focuses broadly on energy. The importance of this research derives from the fact that energy systems provide enormous benefits and pose huge liabilities. Energy use is both essential to economic prosperity and an important cause of environmental problems. The objectives of UCEI's research are to solve important energy problems, enrich the faculty through the intellectual challenges inherent in these problems, and increase their research funding opportunities. Energy Institute research covers the general areas of resources and supply technologies, energy use efficiency, and the impacts of energy use on health, the environment, and the economy.

http://www-path.eecs.berkeley.edu/ucenergy/

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