International Experience in Transmission Open Access

1994 PES Summer Meeting panel session on regulatory considerations, bulk power transactions and pricing, and impact on power system operation and security

T.W. Hissey, Panel Session Chair, Macro Corporation, USA

Welcome to our International Experience in Transmission Open Access. In support of the 1994 IEEE PES Summer Meeting theme of Bridging the Globe, we are pleased to have power system engineers from the United Kingdom, the European Community, Sweden, Spain, Italy, Australia, New Zealand, Chile, Argentina, and the United States to present information and lead our discussions on transmission open access.

- **Transmission Open Access**: technical paper on international experience, and an overview of the United Kingdom's experience
- **Regulatory Considerations**: panel session providing perspectives from Chile, the United Kingdom, and Australia
- **Bulk Power Transactions and Pricing**: panel session providing perspectives from New Zealand, Argentina, Chile, Peru, and Sweden
- **Impact on Power System Operation and Security**: panel session covering reliability concerns regarding parallel flows, challenges for large transmission and interconnected systems, and lessons to be learned from the England and Wales system.

Each of the panel sessions has a moderator and recorder. At this time, I would like to gratefully acknowledge the assistance of Hugh Rudnick of the Catholic University, Santiago, Chile, for his work in helping to pull together these sessions, as well as the authors, panelists, moderators, and recorders.

As recently summarized by Jack Casazza, in an article in the 1994 Power Technology International magazine, "Over the past few years, third-party access to transmission lines has been hotly debated throughout the world. Political attempts have been made in some countries to ram through new policies, rules, and regulations without adequate analyses, some successful, and some not. It is increasingly recognized that third-party access can affect the cost of electricity, the environment, and the reliability of our electric power systems."

Electric utilities throughout the world are in a transition mode, whether publicly or privately owned. They must be flexible, innovative, and aggressive in their marketing, planning, and operations.
systems." Those words, along with the comments of the participants in the excellent plenary session, form the backdrop for our activities. Electric utilities throughout the world are in a transition mode, whether publicly or privately owned. They must be flexible, innovative, and aggressive in their marketing, planning, and operations as we move into the twenty-first century. They must also have the appropriate personnel, analysis tools, and automation so that they can react appropriately to the rapidly changing playing field on which they find themselves. There is no doubt that the utilities are striving to provide quality, stable, and reliable electric power supply in an effective and efficient manner. However, they are, and will be, under many conflicting pressures.

On one hand, the utility finds itself bound by the regulatory environment in which it must operate. Regulatory policies and commission decisions are not always established to allow sound power engineering, planning, or operating decisions, but these are the conditions under which we must operate. Next, the competitive world in which we (as engineers) must operate has now reached beyond the suppliers of consumer products, systems, commodities, and services to the electric utilities themselves. The traditional, vertically structured electric utility, or tomorrow's structure, whatever form it takes, must be flexible, innovative, and aggressive as it strives to stay afloat in the turbulent competitive sea.

Couple these driving factors with the operating restraints on the utilities, and we see some utilities restructuring, as well as downsizing, in order to be able to stay in business. When I look at the electric utility generation, transmission, and distribution portions of the business, I consider one of these areas, the generation business, to be an area of reasonable competitive freedom. The other two I consider as basic monopolies. I would term the transmission area more or less a natural monopoly, and the distribution area a geographic monopoly.

The generators of power today, which include utilities, nonutility generators (NUGs), and exempt wholesale generators (EWGs), must operate in a dynamic and highly competitive market. This basic competition, as well as the need to transfer the power to the purchaser, has brought the subject of transmission open access to a head on many of the continents of the world.

Third-party transmission access considerations have really been underway in North America for many decades; consider wheeling power from a supplier to a purchaser over a third party's transmission. However, several United States regulatory decisions have created the high interest and hot debates on transmission access today. The 1992 United States Energy Policy Act (EPA), which introduced the EWGs, basically opened Pandora's box.

Partly due to the EPA and partly due to the pressures of our economy, the electric utility industry in North America is changing. Utilities are evaluating the roles they can effectively and efficiently perform with their present structure, and some have already decided to separate the previous integrated elements. As companies restructure, new players, new business opportunities, and combinations of segments of former vertically structured utilities will emerge to compete in a given area.

The fact that the 1992 law gave the U.S. Federal Regulatory Commission (FERC) greater authority to order utilities to provide transmission access, as well as establishing several new added standards for state regulators to consider under the Public Utility Regulatory Policies Act (PURPA), has instigated changes that will greatly affect future electric utility operations, planning, and organization structure in North America.

Since several regions of the world have already struggled with transmission open access (TOA), the thought was to gather some of those that had gone through a similar, more or less parallel experience, and listen and try to learn from that experience, in this topic of very high interest in North America. Without further delay, I would like to proceed to the main/technical portions of the program and introduce the technical paper for your consideration and discussion.

The following panel session speakers address the issues surrounding transmission open access:

- Ignacio Perez-Arriaga, Universidad Pontificia Comillas, Madrid, Spain
- Hugh Rudnick, Pontificia Universidad Catolica De Chile, Santiago, Chile
- Renato Agurto, Syner, Chile
- Steve Drummond, National Grid Company, United Kingdom
- Hugh Outshed, University of New South Wales, Australia
- Mike Moy, Trans Power, New Zealand
- Sture Larsson, Swedish Grid Company, Sweden
- Art Garfield, Ohio Edison, United States
- Luigi Salvaderi, ENEL, Italy

Transmission Open Access

The opening technical session provides an introduction to the subject of transmission open access and an overview to motivate the other panel discussions.

International Power System Transmission Open Access Experience

Ignacio J. Perez-Arriaga, Universidad Pontificia Comillas, Madrid, Spain; Hugh Rudnick, Pontificia Universidad Catolica de Chile, Santiago, Chile; and Walter O. Stadlin, Macro Corporation, United States

This technical paper, "International Power System Transmission Open Access Experience" (94 SM 489-5 PWRS), was presented by Dr. Perez-Arriaga. It covers open access format (including electric system structures and transaction characteristics) and economic/operational issues. The paper is available from IEEE and will be published with discussions and closure in the IEEE Transactions in Power Systems.

United Kingdom's Experience

S.M. Drummond, National Grid Company Plc, UK

For any electricity industry considering altering their existing structure or pooling arrangements, it is vital to carefully consider what the objectives of changing are, what commercial arrangements and economic drivers should be
put in place to achieve these, and what their long term effects might be.

**Competitive Environment**

At the present time, the commercial arrangements for energy markets around the world are as varied as the range of interconnected systems; but, there is a current trend towards wholesale market reforms that share the common theme of introduction of competition. Most efforts have been aimed at unburdening the large monopolies and the introduction of a competitive regime, which it is hoped will encourage initiatives for efficiency improvements.

The real challenge, however, is to implement arrangements that will produce sufficient competition to realize and sustain any gains that are possible and are applicable to the particular system in question. Most policy makers who have wanted to stimulate new approaches to commercial pooling arrangements have favored strategies of: introduction of increased competition in the generation and retail supply sectors, providing customer choice and downward pressure on prices; introduction of a mechanism for customers and generators to have nondiscriminatory access to the interconnected transmission network for the purposes of trading, i.e., open access; and transparency of transmission and distribution prices.

In the England/Wales Pool, the commercial pooling arrangements used are relatively unique in that they adopt a multiple compensation approach. That is, the generators receive both their capital and operation costs from a combination of payments from the pool and from suppliers consisting of energy payments, capacity payments, and contracts for differences with suppliers.

Generation competition is introduced through either these contracts for differences, which act as a hedge for the parties against the pool price, or through participation in the pool market unhedged. The pool purchase price is set in a competitive environment with price setting generators bidding to be scheduled for dispatch.

Transmission and distribution are regarded as monopoly businesses, and regulation of their income is through the use of an all-inclusive cost constraint. An important first step in the introduction of effective commercial pooling arrangements, and in particular a system which promotes competition amongst participants, is opening up the networks in a nondiscriminatory manner, to provide access to all parties wishing to trade. This is referred to as third-party access by some authorities. In England and Wales, we have an open access system. The National Grid Company charges for entry to, exit from, and use of the transmission system on a nondiscriminatory basis, although it does have a zonal charging system that tries to encourage generation and demand investment in the right places.

**Factors Affecting Open Access**

In considering what new structure to put in place to achieve open access, our experience has been that a number of factors have to be taken into account: physical system, social constraints, economic and commercial issues, investment, and regulation.

Ultimately, it appears desirable that market regulation should have the following characteristics. It should:

- Be light-handed
- Provide for an independent oversight of the industry both in terms of market behavior and monopoly pricing
- Be even-handed in its treatment of public and private participants
- Retain a central role for market participants to determine industry standards and technical requirements

Perhaps most importantly, protect legitimate community interests while still allowing the industry to develop in a way that maximizes economic welfare.

There are a number of commercial pooling models that could be applicable in the establishment of an effective power pool, and it is essential in developing the commercial arrangements to recognize the uniqueness of the market place to which they will be applied. The final choice of the commercial arrangements will be primarily influenced by regional political motivations and regulatory constraints, but it is vitally important to the effectiveness of the final results that initial debate focuses on objectives and outcomes rather than process.

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**Regulatory Considerations**

This panel session reviews the regulatory decisions in countries in which open access systems have been in operation. It focuses on experiences to date and lessons for the future.

The panel session moderator was K. Zadeh, ZME, United States; and the panel session recorder was Hugh Rudnick, Pontificia Universidad Catolica De Chile, Santiago, Chile.

The three presentations in this panel session provide an overview of regulation developments and plans in three different continents in relation to transmission open access. The Chilean experience, one of the earlier initiatives of electric sector deregulation aiming at creating a competitive generation market with the use of transmission open access, is described first. Renato Agurto, one of the creators of the Chilean Electricity law, illustrates the basic concepts behind the law. A second experience that has been observed with increasing interest is that of the British electric sector. Radical changes reshaped a traditional, state-run large electricity utility in which access to the transmission systems was considered necessary for wholesale and retail customers to receive the benefits of a competitive market environment. S.M. Drummond, from the new British transmission utility, the National Grid Company, reviews the need for transmission utility regulation and how the UK regulator has dealt with the question. Based on the British experience on regulation of vertically integrated monopolies, he provides some thoughts in relation to the reforms being taken in California. Finally, Dr. Hugh R. Outhred, from the University of New South Wales, describes the plans and experiments made for a future implementation of a competitive electricity market across the southern and eastern states of Australia. Open access regulation is at the heart of the changes, and lessons from the experiments are shared.

**Chilean Perspective**

Renato Agurto, Synex Consulting Engineers, Chile

Over 85 percent of generation facilities and almost 100 percent of the transmission and distribution systems are
privately owned in Chile, forming an essentially decentralized power sector. This was the result of the application since 1979 of a set of policies oriented to establish economic efficiency including planning and investment coordination, pricing, economic load dispatch, and common use of the transmission system.

**Regulatory Framework for the Power Sector**

These policies were implemented by the National Energy Commission, created in 1978 to assist the government to formulate plans and policies for the Energy Sector. Thus, planning procedures and tariff policies were implemented between 1978 and 1981, and the new legal and regulatory framework was established in 1982; after that, the framework was completed through bylaws and improvements of the electric law.

The competition and decentralization policy applied in Chile for the electric generation sector, with free entry of any generator, free access to distributors and big customers and free prices for these customers, have as fundamental requisites the transmission open access (TOA). This is because given the transmission systems’ scale economies, they constitute natural monopolies. It is necessary, then, for market conditions to be regulated in order for these systems to be used by the various generators that are to operate in the market.

**Requirements for the TOA Regulatory Framework**

The main requirements for the TOA regulatory framework in Chile were to:

- Allow the widest competitive market, both the spot market and the long-term contracts market
- Provide the resources required to develop the transmission system
- Supply efficient price signals to the producers and consumers of electricity.

To meet these requirements, the following considerations were adopted in the design of the pricing scheme for the transmission system, and the generation charges:

- Prices and transmission charges have to recognize the relative localization of generators and consumers in the market, then node prices are differentiated through marginal cost of transmission (cost of the marginal losses) the transmission tolls are different for each generator; in this sense, the simple schemes (constant connection fee or postage stamp rates) were discarded.
- The short run efficiency in the dispatch of generation has to be preserved, through using short run marginal costs (SRMCC) to compute the transfers of energy in the spot market, and making transmission tolls independent of the dispatch of the generating units.
- The scheme had to be easy to apply with minimum intervention of the regulatory entity.

**Main Characteristics of the TOA Regulatory Framework**

The Chilean electric law provides for rights of use, or rights of way, that generating companies may impose on third parties’ transmission systems, and establish the general conditions that must hold for such rights to be exercised. The law leaves it to the parties to negotiate the determination of the toll fee to be paid by the user, under a framework given by the law. In case controversies should arise, these shall be solved through arbitration.

The payment or toll fee scheme established in the law for the use of the transmission systems is consistent with the electricity tariffs at marginal cost. The price system applied for electricity at the generation-transmission level in Chile is based on short-term marginal costs. Thus, transactions of electricity among generators, managed by the Economic Load Dispatch Center (CDEC), are valued at strict marginal costs in the input and output bars; supply from generators to distributors is calculated at a price equal to the average of the expected short-term marginal costs in the electric system for a given period, and supply to large users is made at prices freely agreed. Given the existing competitive conditions, these free prices are also governed, in the last instance, by short-term marginal costs. This tariff scheme gives the transmission systems’ owners a net yearly income which, in the presence of scale economies, is not sufficient to cover the total economic cost of these systems. The toll fees agreed upon by generators with the owners of transmission systems therefore correspond to the difference between the total yearly cost of the transmission system and the net income yielded by tariffs. The toll fees for the use of the transmission system lie exclusively between generators and transmitters, there being no explicit mechanism for transferring these payments to end customers, neither directly nor through distributing companies.

One of the main characteristics of the Chilean approach to TOA is to assign the cost of the transmission system considering the use of the facilities by the generators. Given that the energy produced by generating companies is valued at the marginal cost of the input node, independently of the outputs they make for commercializing it at the consumption points, it became necessary to distinguish between two uses of the transmission system for the purpose of collecting toll payments: a basic use, determined by the influence area of each generating unit, which comprises those transmission facilities that are affected by the power plant’s generation, independently of the commercialization of the energy produced, and an additional use, dependent on the specific transmission facilities used for commercializing the energy produced, over and above those involved in the basic use. The key point of this approach is the distinction between the natural and the commercial use of the transmission system.

The influence area of a generating unit is comprised by those installations of the transmission system to which increases in energy flows occur when an incremental change is made in the output of the unit accompanied by a reduction of the generation of the marginal unit. The basic toll, defined by the influence area, permits the generator to sell electricity in any node included in the influence area and in those located at counter flow of the influence area. It must be
pointed out that influence area, valuation of the energy at SRMC, and payment of the basic toll by the generators are linked concepts. If the generator wishes to sell electricity outside of its influence area, it has to pay transmission use tolls, which are determined on a case-by-case basis.

**Effects of the Tolls in the Price System**

It must be noticed that since prices at the main market place are competitive, they cannot be artificially raised, because the generators located nearer the market put a roof to the price (the SRMC); consequently, the generators located far from the market have to support their higher basic toll. In this sense, any new power plant project has "to wait" until the prices (SRMC) rise enough in the market to support its own costs: investment and O&M of the plant plus transport of the energy to the market (basic toll).

**Application of the TOA Regulatory Framework**

With respect to the influence areas and basic toll, there were initial difficulties in the application of the legal rules directly by the parties (generators and owner of the transmission system), but the arbitration procedure considered in the law was used to solve the problems. Thus, currently the influence areas have been defined for all power plants, and the basic tolls are being paid by generators. With respect to the additional tolls, there were initial difficulties in the case-by-case negotiation of the tolls, because the implementation of the rules directly by the parties took more time than predicted, but it is currently functioning. The generators and the transmitter, through a consultancy made through the CDEC have contributed to improve the application of the legal rules.

Finally, a wide experience of application of the regulatory framework of the TOA in Chile has been accumulated. This experience permits us to improve the regulatory framework, probably through a bylaw.

**British Perspective**

S. M. Drummond, Interconnections Business, The National Grid Company Plc., United Kingdom

Why is regulation needed in utilities' networks? Both the concept and the achievement of competition is difficult in utility industries, where networks such as those for electricity and gas provide the means to compete. Where a dominant network owner (and, more often than not, a monopoly) controls access to providers and consumers, it is unlikely that market forces alone will lead to optimal efficiency. This is because the dominant player can use its market power to gain maximum returns.

In industries such as electricity and gas, the prospect of effective competition in the distribution and transmission of energy is remote, due to the advantages that the monopoly owner receives and gives from economies of scale. This has been recognized by most (if not all) policy makers, and their strategies have concentrated on achieving competition within either the generation and supply ends of the industry or both. Nevertheless, one of the key aspects in the development of competition in the potentially competitive areas of the market (i.e., generation and/or supply) is the provision of open access to monopoly networks on fair and equitable terms. This ensures that both existing and potential competitors can deliver their product to the market and that they will not retain or be competing against players with an unfair advantage in doing so. Access to the network, if not provided equitably, can be the most direct barrier to entry for new competitors in the utility industries. This has been fully acknowledged in the UK and, albeit very slowly, it is being accepted in the rest of Europe as well.

**Role of the Regulator and the UK Experience**

Ideally, regulation should generally be light-handed, provide for an independent oversight of the industry in terms of market behavior and pricing, be even-handed in its treatment of public and private participants, retain a central role for market participants to determine industry standards and technical requirements, and protect legitimate community interests, while still allowing the industry to develop in a way that maximizes economic welfare.

In the UK, and from the regulators' point of view, access to utilities' transmission systems is necessary for wholesale and retail customers to receive the benefits of a more competitive market environment. Promoting competition in the electricity supply industry is a key obligation placed upon our regulator, the Director General of Electricity Supply, and involves encouraging the entry of new competitors into the market. Thus, the policy question for the regulator in these circumstances is how to promote and maintain effective competition in generation and supply in the face of monopoly-related activities.

Regulatory concerns in the promotion of competition involve ensuring that the monopoly network owner does not employ predatory pricing, provide unfair or unequal market access, or provide barriers to entry against potential new entrants. Examples of this include adversely raising charges for access to the network or offering selective discounts to customers that are offered services from other suppliers.

The main concerns to the National Grid Company (NGC) have been the provision of open and equitable access to the transmission system and the way in which it charges for transmission, such that the charges are set in an economically efficient and sustainable manner resulting in the correct economic signals being sent to the market. In order to provide a level playing field in which competition can develop, NGC's Transmission License lays down the rights to access and contains:

- Price condition to ensure that charges are set at such a level that no over or under recovery of costs would generally result
- Obligation to publish the basis of charges for use of the transmission system and connection to the system coupled with a requirement for transparency
- Obligation to publish a statement on an annual basis showing in respect of the seven succeeding financial years circuit capacity, forecast power flows and loading on each part of the transmission system, and fault levels for each transmission node
- Nondiscrimination condition in the provision of use of the transmission system and connection to the system
- Requirement to offer terms for connection to the system, regardless of where the user wants to connect, within 90 days of application for connection (implicit within this offer will be the ongoing charges for use of the system)
- Prohibition condition in the use of cross-subsidies between separate businesses to prevent preferential pricing in potentially competitive or contestable areas
- Prohibition condition in the buying or selling of electricity (other than for the purpose of the generation - in our case the Pumped Storage Business and Ancillary Services) Business to prevent a conflict of interest on the part of NGC.

One way of measuring the success of these provisions is to look at the transition over time to a more competitive market. In electricity, this has happened much faster than

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expected. Over 3,200 MW of new independent capacity is already in operation since vesting in 1990, accounting for 5 percent of total market output. The combined market share of National Power and PowerGen has fallen from 78 percent at vesting to 60 percent in the last financial year. Further, new capacity is under construction, including 1,254 MW from Nuclear Electric and 2,600 MW from independent.

In the case of a vertically integrated monopoly such as British Gas (BG), regulatory concerns increase as it is in BG’s interest to prevent competitors from reaching the market. In fact, BG had an unfair information advantage over competitors, since its ownership of the gas pipelines allowed it to know in advance its potential rival’s intentions to supply gas. Faced with this problem, the regulator can engage in entry assistance involving positive steps to assist new players to overcome the obstacles and initial disadvantages when trying to compete with the established dominant privatized utility. In practice, this means subsidizing entry by extracting favorable interconnection and other terms for the new entrant in order to help overcome the initial hurdles it faces. This is a marked departure from the idea of regulation based on a level playing field. However, the alternative strategy, that of accounting separation and strict regulation, although the UK experience with British Gas suggests otherwise. It is my view that the commission should move more in this direction, or at least retain the sanction to require divestment in the event that the regulatory initiatives should prove insufficiently effective.

One last point: the key to an efficient and effective generation market, as recognized by the CPUC proposals, is access on equitable terms to the transmission grid. However, if grids are to remain separately owned and managed, then there must also be common cost principles and equitable costs of access across all of the interconnected grids. This effectively means establishing costs for transmission services across the grids, with revenue limits for these regulated activities. They could be based on the costs that a “typical efficient operator” would incur, with reference to comparative analysis of costs across the interconnected utilities (and possibly elsewhere in the US) to establish best practice benchmark costs. This could apply not only to the cost of connection and transport services, but also so-called “ancillary services” such as system control and dispatch.

However, I observe that the CPUC has not mentioned how it is going to determine a fair means for pricing and cost allocation, when the current utilities’ packages are separated out into unbundled services. This obviously needs to be done and, following on from this, is the problem of devising a method of charging for transmission that will be economically efficient and send the correct signals to the market, principally for investment purposes.

**Issues for California**

Turning to issues that might affect California, the California Public Utility Commission (CPUC) is currently proposing reform within the electricity sector to introduce competition at the retail level and implement performance-based regulation. These proposals, as I see it, are leading the way for reforms in the United States and are likely to be at the forefront of any debate on open access as a means to achieving effective competition, which, in turn, (it should not be forgotten) is the means to achieve price reductions.

The CPUC suggests that competition can be achieved through retail wheeling utilizing vertically integrated utilities. Lessons can be learned from the UK experience with British Gas as to the problems that could arise, and the associated regulatory burden with this kind of market structure. Constructive action needs to be taken before the proposals are implemented to ensure the nondiscriminatory treatment of all competitors, as opposed to afterwards when any kind of reform would be much more difficult.

However, my perception is that the proposals to promote effective competition and provide open access on equitable terms to transmission would seem to sit uneasily with the other stated intentions of leaving the industry structure and the utility franchise fundamentally intact. Retail wheeling effectively removes the “obligation to supply” currently placed on utilities and a requirement to provide standby is far short of the “obligation”. If it is not, it will lead to greater inefficiencies.

The alternative of divestment of generation from transmission would give two clear advantages in the development of competition.

- Since generation is a naturally competitive activity, divestment would allow regulation of this activity to be greatly lessened compared with the level that might be necessary if it remained part of a vertically integrated utility.
- Clear separation of generation from transmission would remove any suspicion that transmission access was being given on preferential terms to an incumbent’s own generation (or for that matter customers).

These provisions might be possible through accounting separation and strict regulation, although the UK experience with British Gas suggests otherwise. It is my view that the commission should move more in this direction, or at least retain the sanction to require divestment in the event that the regulatory initiatives should prove insufficiently effective.

**Australian Perspective**

Hugh R Outhred, School of Electrical Engineering, University of New South Wales, Australia

Australia, like many other countries, is considering radical changes to its electricity industry, which has to date been publicly owned and organized at the state rather than federal level.

Prior to the establishment of the Government Pricing Tribunal of New South Wales (NSW) in 1992, industry regulation in each state was by a reporting process to the state parliament through the relevant minister. The Government Pricing Tribunal of NSW was created to provide a more formal and independent regulatory process. This was felt to be more consistent with the NSW government’s desire to create a more business-like atmosphere in what is to remain at least for the present a publicly owned industry. The government has more recently created separate generation and transmission entities. Distribution has always been a separate function in NSW, presently conducted by 25 distributors, each with a franchise service territory. Victoria is currently undertaking a similar disaggregation process.

**Changes Being Considered**

These initiatives form part of a country-wide trend towards commercialization of the electricity industry. Specifi-
ally, in July 1991, the state and federal governments decided to create a National Electricity Grid that would involve a competitive electricity market across the southern and eastern states of Australia. Initially, the three states that are already interconnected will be involved (New South Wales, Victoria, and South Australia). Interconnections to other states (Queensland and Tasmania) are being considered. Interconnections to Western Australia and the Northern Territory are not presently feasible, and these states are independently looking at commercialization of their industries.

The state and federal governments established the National Grid Management Council to oversee development of the National Grid. The Council released the first version of a National Grid Protocol in December 1992. It had three central features:

- Encouragement of trade in electricity through nondiscriminatory access to the National Grid
- Guidelines for competitive sourcing of new capacity, including demand management
- Public reporting and review procedures.

Generators of at least 30 MW and consumers with demands of at least 10 MW are eligible to be parties to the protocol. The aim is for all participants to be able to freely trade in bulk electricity through the National Grid, with the charge for the use of the grid publicly known.

Since the protocol was released, attention has focused on how it should be implemented, particularly with regard to the provisions for open access. Consideration has also been given to the nature of regulation. A 6-month “paper trial” of a possible implementation of the protocol commenced in late 1993 and was recently completed. Important features of the trial were as follows:

- It simulated commercial trading by all eligible participants to the protocol (participation was optional for direct consumers).
- Generators submitted bids into an enhanced version of an England and Wales style pool.
- Transmission charges were implemented as demand charges, which were determined by the “benefits method,” a locally developed cost-allocation method that uses a network load-flow model.

The paper trial corroborated some well-known limitations of the England and Wales style pool:

- Centralized unit commitment and dispatch can produce counter-intuitive pool prices and can reward gaming by generators.
- An unsatisfactory physical market does not provide a sound basis for trading financial instruments.
- Provision for demand bidding is inadequate.
- Provision for dealing with network constraints is inadequate.

Thus, unfortunately the paper trial raised as many questions as it answered; but, it did clearly demonstrate the value of experimentation prior to implementation of an open access protocol. At this time, debate continues to rage on the best approach. There are essentially two schools of thought:

- Bilateral trading with some form of transmission charge
- Improved versions of the pool approach, such as the Nodal Auction Model.

The main difference between the two options is that the former assumes independence between bilateral trades and leaves operation scheduling decisions to the parties to the bilateral contracts, whereas the latter embeds a network model into a multiphase electricity spot and forward market, which would also support decentralized operation scheduling. Neither option has an established track record of success.

### Regulatory Considerations

In broad terms, regulation of the electricity industry can be thought to have four main objectives: economic efficiency, social policy (e.g., equity considerations), technical regulation (e.g., quality of supply and safety criteria), and management of external impacts (e.g., environment, health). It is important to note that these objectives interact and must be addressed jointly. For example, the technical and economic objectives interact through quality of supply. The interaction is more critical in a competitive industry than in a monopolistic industry.

One of the commonly claimed benefits of competition is a reduced need for economic regulation, so called “light-handed” regulation. The assumption is that competition can improve economic efficiency. It is generally agreed that competition is easiest to implement in generation, except perhaps in countries in which hydro resources dominate, such as New Zealand.

Practical experience in Australia with the paper trial has provided two lessons which have also been learned elsewhere:

- The ability of competition to enhance economic efficiency depends strongly on the details of the market implementation.
- Governments and industry participants have mixed feelings about economic efficiency. While they usually support the principle, they prefer that it be applied to others rather than to themselves.

“Light-handed” regulation is perhaps better thought of as “process” regulation in which the objective for a commodity industry is to design a market process that will deliver “fair market clearing prices” (by contrast, traditional regulation may be thought of as being “outcome” oriented, aiming to set prices administratively). With this perspective, we can focus on where process regulation is likely to work, and on what is required to make it work. To discuss this, it is helpful to draw on some of the concepts in the nodal auction model:

- Generators and consumers are located at nodes in an electricity network, each of which, in commercial terms, acts as a nodal market.
- In commercial terms, the network provides arbitrage between the nodal markets within agreed operating constraints.
A computer-based spot and "technical forward market" with an embedded network model resolves location-specific bids and offers by consumers and generators for a set of consistent nodal spot and forward market clearing prices in the operation scheduling horizon. This procedure takes account of all arbitrage opportunities provided by the network within its operating constraints. It also provides coordinated, decentralized unit commitment.

We can deduce that fair market prices are more likely to be achieved where the network arbitration function is strong and there is good liquidity in the linked nodal markets. It is less likely to be achieved where the arbitration function is weak and nodal markets are poorly coupled. That is, fair nodal market clearing prices are more likely in the main transmission network and less likely in radial distribution networks. Put another way, competition in bulk electricity markets is likely to be more efficient than competition for small consumers in retail markets.

From reasoning of this type, I deduce that it makes sense to develop competitive bulk electricity markets and to retain distribution franchises for small consumers (it may be appropriate to implement the distribution franchises on the basis of distribution planning areas where vertically integrated utilities currently exist). For a number of reasons, I believe that the nodal auction model is the best way to implement a competitive bulk electricity market. One reason is that it is very amenable to process regulation. Note, however, that regulation will still be required. For example, network operating constraints are matters of judgment that should be managed cooperatively, perhaps by a supervised "club" process.

Having separated distribution from the bulk electricity market, we can now address the problem of distribution regulation from an energy-service perspective rather than a commodity perspective. This allows us to carry over, in a modified way, two important ideas from traditional industrial regulation: obligation to serve and integrated resource planning.

These ideas can now be stated in a combined form as the obligation on a distributor to assist its franchise consumers to achieve least-cost energy services, using electricity, gas, efficiency measures, distributed generation, or storage as appropriate. Regulation of distributors could make use of tools such as revenue cap and benchmarking. Distributors could be required to prepare integrated resource plans for a 3 to 5 year period, involving extensive public participation. They could be required to hold forward market positions for the expected bulk electricity requirement identified in the integrated resource plan. Where possible the regulatory focus is on process not outcome.

Need for Coordination

It is easy to talk about introducing competition into the electricity industry, but it is difficult to do it well. It is easy to talk about light-handed regulation, but it is difficult to do that well. A coordinated approach is required to the design of competitive industry structure and its regulation. Where possible, regulation should focus on process, not outcome. Different forms of regulation are appropriate for the bulk electricity market (a commodity industry) and for distribution to small consumers (a service industry). In Australia, final decisions have yet to be taken about the form of the competitive market and the nature of regulation. There is still the possibility, but by no means the certainty, of a sensible outcome.

Bulk Power Transactions and Pricing

This panel session reviews assessment methods for use of system valuation in bulk power transactions, including the contract, transaction, and pricing schemes.

The panel session moderator was A. Breipohl, University of Oklahoma, United States; and the panel session recorder was Ignacio J. Perez-Arriaga, Instituto de Investigacion Tecnologica IIT, Comillas University of Madrid, Spain.

The three presentations in this panel session describe the methods being used or proposed for transmission system valuation of bulk power transactions in several countries belonging to three different continents. Some of those countries are presently in the process of adapting their transmission pricing schemes to recent regulatory changes allowing for transmission open access. The presentations on New Zealand and Sweden contain a brief descriptions of the current regulatory framework; similar information on Argentina and Chile can be found in presentations from the other two panel sessions.

New Zealand Perspective

Mike Moy, Trans Power, New Zealand

The New Zealand economy, including the electricity system, has been through a process of major reform. Historically, the electric power industry was dominated by publicly owned monopolies, with almost all electricity being generated and transmitted by a governmental department and locally distributed and sold by electricity supply authorities with exclusive franchise areas.

Reform Process

In 1987, the Electricity Division of the Ministry of Energy was corporatized as Electricity Corporation of New Zealand (ECNZ), which generates 96 percent of all electricity. Generation was deregulated in 1988, but so far competition has been very limited. The transmission grid is owned, managed, and operated by Trans Power New Zealand Limited. Progressive deregulation of retailing has taken place during 1993 and 1994. There is transmission open access, network and energy charges have been unbundled, the distribution power companies have been also corporatized, and there is financial separation of the functions of retailing and distribution.

Retail competition is supported by small independent generating units. Retailers selling outside their own distribution networks must enter into an agreement to reconcile metered quantities with contractual traded quantities. Trans Power, as an independent party, acts as National Reconciliation Manager. Trans Power contracts with distributors for connection to the grid. Energy traders gain access to transmission and distribution through use of system agreements with distributors. All transmission and distribution contracts have to be disclosed.
The noncompetitive sectors of the electricity industry are subject to "light-handed" regulation, i.e., the prices are not directly controlled, instead general rules are defined. However, the Commerce Act (1986) contains provisions for price control (also applicable to gas, telecoms, airports, etc.) that can be envisioned as a threat of "heavy-handed" regulation.

**Trans Power Pricing**

The overall objective of Trans Power is to provide efficient, reliable, and secure transmission services. As a separate commercial entity (state-owned enterprise), Trans Power must operate as a successful business, earning an adequate rate of return, having regard to the risk of the business. Trans Power must comply with its public policy objectives:

- Provide access on a non-discriminatory basis to existing and potential customers
- Promote efficient use of energy and economic resources via pricing and contracting for transmission services
- Provide information to the network users which facilitates efficient and coordinated investment decisions.

Trans Power’s pricing policy is based on cost recovery. The calculation of Trans Power’s energy requirement is essentially based on a return-on-assets approach. The assets are regularly revalued using the optimized depreciable value (ODV) method. The ODV method takes into account the age of the assets and the extent to which they require maintenance, to provide a valuation at depreciated replacement cost. Where the assets in place are clearly in excess of what is required, the utility of the assets is taken into account by discounting the value of the assets to the value of the optimal grid assets.

Costs that can be identified with specific assets or services provided by Trans Power (such as customer-specific connection charges, asset-specific maintenance charges, and new investment charges) are charged with the philosophy of "user pays."

A large proportion of Trans Power revenue requirement (i.e., the sunk costs of most of the existing grid) is not directly attributable to specific users and is allocated by a mechanism that divides it equally into "network charges" (under the principle of "user pays") and making prices vary with the distance between load and generation, and with the power flows in the system near times of system peak) and "capacity charges" (which reflect the "common good" aspects of the grid, regardless of the location, and result in prices that are based on the power consumed during certain prescribed peaking conditions in the system). The underlying philosophy is that distributors and consumers are the actual end users of the network.

Variable transmission charges, which comprise mainly the marginal losses charges, are contained in the energy prices at each connection point and not with the above charges in the grid connection contract. Presently, Trans Power calculates transmission losses over typical scenarios to give average transmission loss factors. In the event of a wholesale electricity market being established, the calculation of variable transmission costs and energy prices could be combined to provide half-hourly nodal energy prices.

Other transmission-related charges, some of them currently under revision, include concepts such as network constraints, dispatch, spinning reserves, interruptibility, and reactive support.

**Further Developments**

Work on development of a wholesale market is in progress. Nodal pricing, including the effect of network constraints, may be adequately handled within this context. New independent generation will increase bulk power competition. A scheme of transmission capacity rights, which is equivalent to financial compensation for price differences between two points of connection, is being considered as a complement to the current network pricing method and the nodal energy prices.

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**Argentinean, Chilean, and Peruvian Perspectives**

**Hugh Rudnick**, Pontificia Universidad Catolica De Chile, Santiago, Chile

Three South American countries have implemented open access as a basic tool of the deregulation of the electric power sector. A parallel is made of the three implementations, which are all based on a common conceptual basis, but have developed differently.

Chile, a country with over 13 million people, a 3,000 MW peak demand, and over 80 percent installed capacity as hydro, started a restructuring process in 1979 that led to a new electricity law in 1982, incorporating an open access scheme in which the transmission owner provides the service to a third-party user only if there is enough available capacity. Argentina followed, implementing open access in 1992; it is a country with over 30 million people, a 9,000 MW peak demand, and over 40 percent installed capacity as hydro. Peru is the newest in the club, with over 22 million people, 2,000 MW peak demand, and over 70 percent as hydro. It innovated implementing in 1993 a common-carrier scheme, in which the transmission company must provide the transmission service, investing when no capacity is available. There are other countries with plans for open access in the region, Colombia being the most advanced one. The challenge is Brazil, with a large system with 55,000 MW installed capacity (95 percent hydro) and transmission investments of $1.3 billion per year; however, plans for open access are only on the drawing board.

The electric sector frameworks set in the three countries aim at the creation of a competitive generation and supply market. Common characteristics are:

- Competition at the generation level (the assumption is that there are no economies of scale in production)
- Short term marginal cost based systems with compulsory centralized dispatch
- Unregulated fees for large consumers (over 1 MW in Argentina, 2 MW in Chile, and 1 MW in Peru)
- Yard-stick regulation for distribution companies and regulated prices for small consumers
- Transmission open access at the key for generation competition.

The transmission business is regulated with the purpose of financing the development of the network and assuring the competitiveness of the market in as much as possible. The presence of economies of scale limit the income obtained from marginal cost pricing, and additional income is raised through the global allocation of network costs to the users. The transmission regulation is loosely defined in Chile, with much freedom of negotiation left to the participants; more tightly controlled by the regulator in Argentina and Peru; the latter countries learned from the difficulties experienced by the first one. The three electrical sectors' frameworks are based on the concept that the social optimum in an economy is achieved when goods and services are priced at marginal cost and systems are economically adapted (an installation is economically adapted when it produces a given quantity at minimum cost).

The ownership of the main grid was assigned to an independent utility, with distributors or generators forbidden to
have control on it, in both Argentina and Peru. In Chile, it belongs to the largest generation utility. Nevertheless, the three schemes rely on the concept that the transmission service must be treated independent of the ownership of the wires.

**Payment of Transmission Services**

There are several questions raised:
- What is to be paid?
- Who is to pay?
- How are the payments shared among payers?

Replacement investment values, corresponding to modern equivalent assets, are paid over a 30-year period, considering a 10 percent rate in Chile (12 percent in Peru). Values are determined by the transmission owner in Chile, while in the other two countries it is done by the regulatory body. Efficiency signals are included in the Argentinean scheme, with penalties for quality modifying an otherwise stable income. In Peru, an economically adapted transmission system determined by the regulator is introduced to stimulate efficient investment, maintenance, and operation. Operation and maintenance transmission costs are added in the three schemes.

The payers of the transmission system are determined through a global allocation of network costs, different in essence to the wheeling methods used in the United States. The main network costs are shared among all participants, through a two-part tariff scheme. A tariff revenue, paid directly by consumers, is increased through a marginal-cost price scheme. The price of energy and capacity at the market (corresponding to the load center located at the capital of each country) is spatially distributed to the buses of the main network through the use of penalty factors, providing prices at all buses. These factors consider only the cost of marginal losses in Chile; the other two regulations have additional mechanisms for adapting those factors, considering the cases of network restrictions that decouple prices at substations. The differences in prices and powers at each end of a transmission installation determine the tariff revenue, a marginal income. In Chile, given economies of scale in 150, 220, and 500 kV lines, an average of 15 to 20 percent of required income is collected by the tariff revenue, demonstrating the need for the supplement.

A second part of the tariff, paid by generators, supplements the tariff revenue to finance the network. The allocation methodology defined for this supplement uses the "area of influence" concept in Argentina and Chile and a "postage stamp" concept in Peru (a connection charge paid in relation to installed generation capacity). The areas of influence are determined by identifying the installations physically and naturally affected by each power plant, irrespective of the commercial use of the network. The supplement payment is distributed among those sharing areas of influence in accordance to peak oriented flows at peak times, with no payment by those using the transmission system counterwise.

**Transactions and Contracts**

The development of contracts for transmission use also have important differences in these countries. In Chile, it is achieved through a negotiation process in which the transmission owner proposes a payment scheme to the interested third party. The proposal specifies values of installations and allocates the payments to that party. A schedule for exchange of observations and questions among the parties is defined in the law, with an arbitration process considered if no agreement is reached. Contracts must last for at least 5 years.

In Argentina, the established procedure for access to the network pretends to assure the operation's continuity meeting reliability and quality conditions, the transparency of the procedure and the competition itself. It considers an analysis of the third-party request by the transporter and the dispatching body (an association of generators, transporters, distributors, large consumers, and the State). The regulator, based on studies by the transporter and the dispatcher, submits the request to a public hearing and finally is responsible for approving it.

In Peru, the regulator is ultimately responsible for approving third-party access and the allocation of the supplement tariff. Studies are made every 4 years or for the entrance of a new generator.

**Experiences to Date**

Open access itself has not developed without problems, particularly in Chile. With no previous experience to rely on, the legal framework defined little and left much to negotiation by the participants, and differences have arisen between generators and transporters, both in the transmission and subtransmission networks. The regulator is in the process of defining terms more precisely. In Argentina, the open access has worked well within its first year of operation (reference: "The free access to the transportation grid in the Argentine system", Rolando Saavedra, Transener SA, July 1994). The system has proved to be very dynamic, about twenty access requests have been submitted, all involving expansions. Nevertheless, no firm conclusions can be drawn. Difficulties have not been significant and have been satisfactorily managed. The main issues deal with disagreements between the access framework and the provincial regulations, presence of independent transporters operating different facilities, tariffs, and payments of expansions.

Nevertheless, even with open access schemes being improved, the experiences with the deregulated processes have been most successful both in Argentina and Chile, measured through different indexes. Electricity prices are no longer subject to exogenous factors (in the past many times determined by arbitrary political decisions) but follow actual availability of hydroelectric energy and fuel prices, providing clear economic indications of the real cost of this kind of energy. The Argentinean sector shows dramatic improvements since deregulation and privatization (reference: "Privatization of the Argentinean electrical sector and its results", Claudia Bahncke, Central Costanera SA, August 1994). Availability of generation plant has increased considerably from a historically low value of 47 percent in 1992 to 70 percent in 1994 and an expected 70 percent in 1996. Productivity of the workforce has improved from 1,098.9 kWh/worker to 1,754.4 in the generation business, and 1,162.7 kWh/worker to 1,785.7 in distribution, pre- and post-pricetization levels. Generation competition has meant going from seven utilities (the largest with 29 percent of the market) to twenty generating companies after privatization (the largest with 10 percent). No comparison can be made in Peru, with its privatization only starting in August 1994.

**Swedish Perspective**

Sture Larsson, Director of Operations, Swedish National Grid, Sweden

> In line with the worldwide trend in many developed countries, the power industry in Sweden is subject to a reformulation in the direction of deregulation and increased competition. The process was initiated in 1990, but the crucial step was taken in late May 1994 when the Swedish
Parliament decided on a new Electricity Act, which is to be instrumental from January 1995.

Due to the strong interconnections to the neighbor Nordic countries, there is of course an interaction between the changes in Sweden and the corresponding processes in Norway, Finland, and Denmark. A fully functional open power market has already being implemented in Norway. The development in Sweden and Finland is virtually in parallel. In Denmark a state energy policy is still prevailing with a very modest market-orientation.

**Swedish Power Industry Background**

The power industry in Sweden has been developed during the last 100 years on the basis of parallel private and state commitments for generation and sales. The structure so far has been characterized by a few large producers, dominated by the state-owned Vattenfall with around 50 percent and Sydkraft with 22 percent of the annual generation. Together with smaller producers, these companies used to cooperate in a closed group in order to minimize internal generation costs. The means have been the trading of power between themselves on a marginal cost basis. Along with spot opportunities for sale and purchase with the neighboring countries considerable amounts of energy have been exchanged. This market has been out of reach for other actors and consumers, which is a major reason why this form of cooperation cannot be accepted under the new Competition and Electricity Acts.

The national transmission grid (400 and 220 kV) was until 1991 owned by the state utility Vattenfall. According to an earlier agreement, the access to the grid was limited to Vattenfall and the main producers. The grid was used on a basis of subscribed channels, with charges related to connected capacity and distance.

By January 1992, a new state authority, Svenska Kraftnet (Swedish National Grid), was formed with the objective to own and operate the grid. Further objectives were given by the government to allow open access to the national grid and to support competition.

The generation capacity is built up of hydroelectric installations located mainly in the north with an average annual yield of 64 TWh. On an average, about 5 percent of the power produced is based on firing of domestic forest products and imported fossil fuels. A substantial nuclear capacity of 10 GW in twelve units is covering the further needs to the annual demand of 140 TWh. Both hydro and thermal stations are state and privately owned in diverse shares according to the historical buildup. A trend of concentration to fewer and larger companies is, however, visible by commercial takeovers.

The national grid consists of 10,500 km of 400 kV lines, 4,500 km of 220 kV lines, and switchgears in some 125 power and substations of various sizes. Many substations are shared with power stations and regional grid owners. Only a limited number of 400/220 kV system transformers belong to the national grid. All other connected transformers belong to the power stations or regional grids. The expansion of the national grid is very moderate due to low demand growth and very few power station projects. Reinforcements of the Nordic and continental interconnections are, however, vital issues in view of the new market situation. The national grid and interconnections are designed and operated according to joint Nordic security standards. Technical requirements and standards for connection to the grid are expressed in specified documents.

**New Legislation**

The present government has shown a determined strategy to reform the power industry by promoting competition and market orientation. The purpose is to improve the position of the consumers and to reach higher corporate efficiency and lower prices. The issue of privatization of state assets has been raised, but it is not implemented so far in the power area. Hesitation to the reform has been demonstrated from the political opposition and some groups representing rural interests. After some initial resistance, the main producers now accept and even welcome the competition orientation.

The opening of the national grid and separation from the state interests in generation and sales in 1992 had little effect on the market. Some attempts to establish new supply relations failed because the old legislation did not support open access to the regional and local grids owned by the utilities. This gave further arguments for changes in the legal conditions. The new Electricity Act reflects the intentions of the government to reach full Swedish membership in the European Union (EU). In compliance with EU regulations, a new Competition Act has also been implemented in 1993.

The main points of the new Electricity Act are:

- All grids within the country are open. Access to the grids shall be given by paying fees only in the connection points.
- Unbundling of grid services from generation and sale is mandatory. Grid companies are entitled to trade with power only for technical purposes in order to cover network losses and alleviate constraints.
- The concession structure is changed. A special supply concession is introduced temporarily to ensure that power will be delivered to customers who wish to stay with the previous supplier.
- A new regulatory authority is formed to supervise grid services, concessions, and tariffs.
- Each grid operator is responsible for the technical facilities for measurements, reporting and accounting towards the market agents who are connected to the grid.
- Swedish National Grid is designated as System Operator with responsibility for system security and load-frequency control.

**Open Access Issues**

**Regulatory**

- Electric system structure
- Transaction characteristics
- Transmission access rights

**Economic**

- Generation business: competitive freedom
- Transmission business: natural monopoly
- Distribution business: geographic monopolies

**Operational**

Power system grid control is required to turn transmission open access policies into practice

- Before the fact: schedule new resources (i.e., transmission facilities)
- Real-time: broker quoted purchases/sales and transmission network control
- After the fact: cost reconstruction and settlements
According to the new Electricity Act, the tariff structure for the grids should meet the following requirements:
- Simple to apply in the new power market
- Give correct cost incentives
- Cover relevant grid costs without any cross-subsidies to or from other activities
- Tariffs on distribution level must not discriminate customers by their location
- Transmission charges should be paid only in the exchange/connection points of each market agent.

Thereby the agent will have access to all grids and is free to trade with any other agent regardless of location.

The main implication for the design of the tariffs is that there must be a coupling between the charges for different grid levels. It should be noted that the national grid and the underlying regional and local grids are owned and operated by different companies with separate economical liabilities. The chosen approach is to design a point tariff structure. Basically, this means that the costs of the national grid are carried by those who are directly connected with power stations or regional grids. The regional grid owner will pass these costs on to those who are connected to the regional grid along with the owner's own relevant costs. Consecutively, the costs from higher grids will be imposed to the lower through the tariffs on regional, local, and distribution levels.

In the entire process, grid costs must be held separate from other costs for the power that is traded. For practical reasons, some coordination in billing, etc., will be accepted at the household distribution levels. The relevance of the grid tariffs is supervised by the regulating authority. It is noticeable that the costs of the national grid (400-220 kV, not including transformers to lower grids) are currently less than 10 percent of the total transmission costs. Of the total cost for electricity at household level, less than 3 percent derive from the national grid.

**National Grid Tariff Structure**

Given the main features of a point-tariff structure, different designs have been investigated to find an appropriate and simple format. The total expenditures that must be covered by the tariffs amount to approximately 2,000 M SEK per year (US$ 296 million at currency rate 1 US$ = 7.50 SEK).

The principal cost elements are:
- Depreciation and financial expenses
- Contracted operation and maintenance of plants, rental costs
- Staff, R&D
- Purchase of power to cover losses, 2.5-3 TWh/year
- Operational costs for reserves and to alleviate transmission constraints.

The extent to which the costs are related to distance and level of transmission has been particularly analyzed. Thanks to the general direction of transmission from north to south, the distance-related costs can be modeled very simply by a geographically linear variation. The chosen solution has been determined as a combination of two main elements, one is capacity and the other is energy related.

The capacity element is charged according to the nominal maximum power level that will be fed into or drawn from the main grid at the connection points. It is also related to the location of the point in the grid on the north-south latitude axis. Power stations in the extreme north will be charged the full capacity fee. Linearly, the fee decreases to zero in the extreme south. Correspondingly, a connection to draw power from the grid is charged zero in the north and full value in the south. The estimated maximum level of the fee to gain cost coverage is 40 SEK per kW and year (US$ 5).

The energy element shall be charged according to the measured energy that is fed into or drawn from the grid. It is

**Operational Implications**

Operations of the National Grid and the power system will be different under the new legal conditions. The general responsibility for system security lies unchanged with the management of grid. The full responsibility of the two main functions described as follows has been moved from the generating utilities to the National Grid Authority.

The new Electricity Act designates the National Grid as System Operator for the power balance and load frequency control. This responsibility is confined to the very short-term operations. Considering the complex hydroelectric management, it has been regarded as suitable that the utilities carry on their own daily dispatching of generation versus contracted sales on an hourly basis. The National Grid will see to the ultimate balancing by calling on necessary regulation from the generating companies in a bidding process. Technical prerequisites and economical settlements will be handled in a certain function separate from the economical management of the grid.

The other function that will influence operations and grid costs is the handling of transmission constraints. In the previous method the generating utilities had access to specified channels through the bottlenecks. Necessary capacity reductions were ordered from the grid operator to the utilities. They had to cope with the constraints by altering the generation dispatching. The costs of this had to be carried entirely by the utilities. This method has not been found consistent with the new open access and point-tariff concept. The current approach is therefore that the grid operator has to allocate constraints by means of rebalancing generation on both sides of the bottleneck. This will lead to out of merit operation, particularly of expensive fossil-fired generation. The generating companies will be compensated for this by a power trading process. The costs will be moderate under normal availability conditions in power stations and the grid. Special severe predicaments may however lead to significant costs that must be covered by the grid tariffs.
Harmonizing Rules, Regulations, and Tariffs

The development of the power market in Sweden is founded on the new Electricity Act. According to this, open access to all grid levels will be given by the connections in specific points. A general point-tariff structure will pass on all grid costs to those actors who use the grid for trading. The National Grid is a part of a mature system with small needs to expand the capacity. The tariff structure is mainly designed to cover capital and other costs to operate and maintain the grid on the existing level. So far, the interconnections are not economically integrated in the general grid tariffs. Further needs for reinforcements are anticipated. The target is set on an integrated Nordic power market. That will require both reinforced interconnections and harmonization of rules, regulations, and tariffs.

Impact on Power System Operation and Security

This panel session provides an assessment of present and future impacts on third-party access to system operation, security, and planning.

The panel session moderator was W. Johnson, PEPCO, United States; and the panel session recorder was Michael H. Schrameyer, Macro Corporation, United States.

The three presentations in this panel session provide an overview of the operation and security concerns in three different countries. In the United States, Arthur R. Garfield discusses the issues pertaining to bulk power transactions and the use of a contract (paper) path versus parallel path (electrical flow) to determine compensation for use of transmission. The General Agreement on Parallel Paths (GAPP) Committee, of which he is the current chair, is charged with developing an effective method of resolving the problems associated with contract versus actual power flows (parallel flows). The evolving electricity industry in Italy was discussed by Luigi Salvaderi from the Planning & Strategies Department of ENEL SpA. He reviews the challenges facing large transmission and interconnected systems and methods to enhance system security on a coordinated system. Steve M. Drummond summarizes the impact on power system operation and security by providing a perspective on the England and Wales system. He identifies the main issues that concern system operators and discusses the impact on operation and security in three different operational time scales: planning phase, programming phase, and control phase.

Parallel Flows: Reliability Concern or Economic Burden?

Arthur R. Garfield, Ohio Edison-GAPP, USA

Bulk power transactions are now accomplished on the interconnected electrical systems of eastern North America as a scheduled transaction, or series of scheduled transactions, between neighboring utilities. All that is needed to effect long-distance transmission is the assembly of a willing chain of neighboring two-party transactions between individual companies. The power is essentially handed-off from company to company according to the chain as described on paper (contract path).

The contract path may yield the ultimate buyer the lowest delivered power cost; but, in many cases, it partially or largely ignores the fact that electricity flows along the path of least impedance. Therefore, companies experiencing a significant portion of the physical power flow, but with no contract recognition, are faced with what amounts to unauthorized use of their transmission system. Such parallel flows may jeopardize reliable customer service at worst, and at least result in an uncompensated use of transmission.

The General Agreement on Parallel Paths (GAPP) Committee was charged by the Interregional Transmission Coordination Forum (ITCF) with the task of developing an effective method of resolving the problems associated with contract versus actual power flows (parallel flows). Progress in this area has become more imperative as the nature of bulk power dealings among companies trend towards longer distance, unidirectional power flows.

After much discussion and weighing of the alternatives, the GAPP Committee has described a method that will work to better control the imposition of parallel power flows on all participating companies. Under the GAPP method, companies will also be compensated for what would previously have been an uncompensated parallel flow. Under this method, parallel flow will be priced by the providers of transmission service according to a public posting of the approved rates, along a predetermined pricing path.

Parallel Flow

Since early 1980, owners, operators, and users of interconnected transmission systems in the eastern United States and Canada have been voluntarily convening to discuss interregional transmission issues with the intent of enhancing cooperation and coordination. The participants refer to themselves as the Interregional Transmission Coordination Forum (ITCF).

One of the most significant issues regarding interconnected transmission system operation is that of unscheduled, or parallel power flows. When power is transferred from one company to another, a single path is arranged by contract for delivery of the power. However, a portion of the contracted power actually flows over other transmission lines and through other systems. The difference between the contracted power scheduled over an interconnection and the actual flow is known as parallel flow (also called loop flow or circulating flow).

The ITCF recognized that significant parallel flow between companies is inevitable and occasionally burdensome to transmission owners and operators who presently have little or no control over others' transactions and who may also receive no compensation for parallel power flows across their systems. To address this issue, the ITCF formed the General Agreement on Parallel Paths (GAPP) Committee.

Current Method: Single Contract Path

Existing transmission systems principally have been designed by companies to carry power from generating units to load centers and to interconnect with neighboring companies in order to enhance overall system reliability and to permit emergency and economy transactions between neighboring companies. The long-standing practice of the electric power industry has been to permit neighboring companies to contract to buy and sell power up to the reliable transfer capability of the interconnections between them. At present, the "contract path" approach is employed in which only the contracting companies exercise control and are paid for the transmission service. They are paid for the full con-
Future: Transmission Open Access

- **Ideal competitive world**: benefits of transaction open access realized through the best possible set of buy/sell contracts.

- **Real world**: even with limitations on transmission access, a significant portion of the ideal competitive benefits can be achieved.

- **Goal**: transmission open access must be accompanied by responsible power system operations to preserve system reliability and achieve desired economics.

tracted power transfer scheduled, regardless of whether the power is actually transported through the contracting companies or not. Companies carrying parallel flows receive no compensation and have little or no control.

One of the problems with this traditional approach to parallel flows is that in recent years, interregional transactions have become predominantly unidirectional for most companies in the eastern United States and Canada. Therefore, the mutual interconnection benefit has, in some cases, become unbalanced due to persistent parallel flows such that some companies must make adjustments and incur costs more than others. "Excessive" parallel flows are therefore increasingly seen as an unauthorized use of transmission, and the costs incurred to accommodate parallel flows are sometimes felt to be onerous.

**GAPP Method Overview**

The GAPP method provides for the scheduling of power transactions along multiple paths which more closely correspond to the actual power flows. The heart of the method is the derivation of a transaction matrix, based on incremental changes to predetermined base-case load flows to show all paths involved in transactions between each and every pair of GAPP participants. The matrix is used to determine the "pricing path", whether entities are transmitting sufficient power to qualify for compensation and the extent to which they have any control over any transaction.

The percentage flow through any particular system has been defined, by GAPP, as the Transaction Participation Factor (TPF). Calculation of TPFs is based upon incremental power transfers. Each participating system is modeled with all major transmission lines in service and the system is dispatched economically to meet its primary demand. The base interchanges modeled in reliability studies are retained. Several methods of TPF calculation have been considered and the net interchange method has been selected. With this method, power flow through a system is determined based on the algebraic sum of the tie flows with each of its interconnected systems. The intent of the GAPP method is to compensate for the usage of a system's transmission and, therefore, the true through-flow should be determined. The net interchange approach will provide a close approximation of the through-flow to meet this intent.

**Threshold for Compensation**

The GAPP method currently envisions that all systems that carry 5 percent or more of any transaction be compensated for the flows through that system.

**Scheduling Transactions**

Several methods of scheduling transactions have been discussed. The method that has been settled on is that the "pricing path" will be used as the scheduling path. In this manner, there will be little change in the scheduling procedures that are currently in common use among dispatching personnel. It is thought that this will encourage acceptance of the GAPP method by dispatching personnel.

**Data Exchange**

A GAPP Information System (GIS) is under development. The current development schedule calls for the system, which will provide the capability of exchanging all power transaction schedule information, to be in service at year end, 1994. Discussions of the final control and compensation concepts and procedures are continuing in parallel with development of the information system. As these are finalized, the program format details will be incorporated into the design of the information system. When the compensation methods for the experiment are finalized and agreed to, a filing will be made with the U.S. Federal Energy Regulatory Commission (FERC).

**Compensation Concerns**

Much has taken place since the formation of the GAPP Committee in late 1989. Several of the conclusions in the original GAPP Report of May 1992 have been modified, due in large part to the inclusion of the viewpoints of transmission-dependent entities, both those that generate and those that have very little generation. However, the basic premises of the original report have stood the test of intense debate: i.e., parallel flows can cause reliability concerns, and a fair, consistently applied method of control for power transactions is required, and, also, the contract-based method of compensation is no longer an appropriate method of compensation in the eastern interconnection. Compensation should be based on actual use of the transmission system as measured by physical power flows.

**Evolving Electricity Industry: Challenges for Large Transmission and Interconnected Systems**

Luigi Salvadori, Planning & Strategies Department, ENEL Spa, Rome, Italy

In 1988, the European Commission (EC) triggered a package of actions aimed at introducing competition in the electricity sector. The original package was based on three stages as follows:

- The first stage (completed in 1988-91) consisted of three directives: information on G&T investments, transparency of prices, and facilitation of transit.
- The second stage, to be started in 1992, was concerned with a further directive on "electricity liberalization" through: abolition of exclusive rights in G&T, unbundling of vertically integrated utilities, and third-party access (TPA) for large consumers (25 MW, 100 GWh/yr) and large distributor (3 percent).
- A third stage, in principle targeted at retail sales, should be defined in the light of the second stage's results.

The "liberalization" directive raised many objections by the industry and also by the energy ministers: the UK example was not considered adequate for other EC countries. And, in general, it was commented that competition may conflict with security of supply: the priority should be given to a common energy policy. After many debates and strong polarization of views (with only UK behind the EC proposal), the European Commission
issued a modified "proposal" on May 4, 1994, on opening up the power sector to competition; major points are:

- Acceptance of unbundling of the accounts instead of the original unbundling of management
- Competition in generation through two options, licensing or call for tender
- Negotiated third-party access instead of the original compulsory access
- Possibility of imposing duties of public service to the companies involved in the business.

So far, some progress has been obtained on the first two issues; debate goes on, on the others. Concerning TPA, one idea emerged, similar in parts to what was suggested by France. It concerns a single buyer as a "buffer" between producers and consumers. Such a buyer, administratively independent, would buy power either from foreign and domestic producers when needed. Under this system, there would be no network access, negotiated or otherwise, for distributors or large consumers. All supply and demand would be coordinated through the single buyer. As concerns the definition and the content of "public service", there are still discrepancies.

The new EU Energy Commissioner stressed the importance of maintaining a constructive dialog with the industry representatives and to benefit from their experience. He also expected that a decision on the modified directive will be reached at the next Energy Council meeting (November 25, under the German chairmanship).

**Reliability and Adequacy**

Challenges to reliability with the increased size of interconnected networks requires consideration of network equivalents, new operation policies modeling of "isolated" versus "pooled" systems, modeling of system losses, interaction of active-reactive power aspects, and coordinated handling of security problems. Composite systems reliability has a statistical content and should be quantitatively expressed by indices (priced). Two aspects of reliability are:

- Adequacy, the effect of outages (generators and components) in steady state
- Security, the effect of transient phenomena

Only the adequacy is so far handled in a probabilistic way; system security is usually assessed in a few "a priori" selected "dangerous" situations.

Two methods for network equivalents (dc approximation) for large system adequacy studies under study at ENEL Spa are the reduced nodal admittance matrix (monodirectional) and the "weighed transfer" of external injections.

Now, operation policies must be incorporated in computing tools. So far, adequacy computing tools contain simplified dispatch policies and usually handle only one system/region. In large systems, potential profitable exchanges are triggered by fuel cost differences, depend on network losses, and may cause overloads and unscheduled loop flows. A shift in models used in planning studies is required from "simple" simulation to optimization (linear or quadratic) techniques. So far, these techniques are mainly used in operation studies in which only a limited number of situations are considered.

**Pooled Operation of Large Systems**

Benefits from pooling a large interconnected system have been studied. A case study has been developed by the VDE System of the UNIPEDE concerning the planned interconnection for the year 2010 of all the systems around the Mediterranean sea. These systems go from the north of France to east of Turkey, Jordan down to south Egypt, and west to the Maghreb countries, and up again through Spain. Eleven countries so far took active part in the study, having almost 500 generators, 1,500 buses, and 1,500 lines with an annual demand of 1,540 TWh and installed capacity of 250 GW. The study provided an assessment of long-term development "coherence framework" and potential fuel gains from a pooled operation. A three-phase approach was undertaken:

- Static study on the busbar system
- Static study on the interconnected system
- Dynamic study on the interconnected system

Complex computing tools handling the generating system optimization as well as optimal power flow for the overall network were used at various steps by EDF, SONEGAZ, and ENEL Spa. Each country made the projections for their demand, generation, and transmission systems. Suitable scenarios for the fuel cost prices were considered. So far, the results obtained from the static studies show that the
Reliability and Security

Recent approaches for solution of security problems by utilities include new methods and computing tools developed for mid-term (6 to 10 seconds) and long-term dynamics (10 seconds to minutes). Tools developed by consultants and utilities include: PSS/E by Fortran, EUROSTAG (EdF, Tractebel), SICRE (ENEL Spa), and others. In particular, EUROSTAG uses one model for generators, AVS, etc., and variable integration steps, while SICRE uses two time self-adjusting models and two prefixed integration steps.

UNIEPEDES has increased cooperation in planning/operation. This international association of utilities has studied "coordinated defence plans" suggested by experts from UCPTE, NORDREL, IPW/UPS. Should major disturbances occur, special protection schemes (e.g., proper disconnection of generation/load) are proposed to avoid network separation and/or collapse. Also, common studies for an "offline" detection of potentially critical situations and related control actions were highly recommended.

I will not address the problem of the transmission pricing in the presence of third-party access, since the first part of this panel session was devoted to it. Nevertheless, I emphasize the need for complex tools for the assessment of the correct value of some of the pricing options. In particular, the correct assessment of the Short Run Marginal Cost of each contractual transaction should on one side reflect the expected value of the special price for 1 year, in probabilistic terms, that results from various system states in various daily/seasonal situations. On the other side, it should include all cost induced by the potential TPA, fuel, voltage support, and so on. In the new framework of increasing wholesales between large systems, caution should be adopted in utilizing "simplified" evaluations in which quantitative results can be misleading. For such studies, the optimal power flow gives a really powerful support.

All of this confirms the strategic position that the transmission system must have in the industry under the impulsion of deregulation, technology evolution, customer expectations, and the correspondent need for powerful, updated criteria/tools to support the utility decisions.

Perspectives on the Operations Structure of the England and Wales System

S.M. Drummond, Interconnections Business, The National Grid Company Plc., United Kingdom

There are four main issues that are of concern to system operators, which remain no matter what the structure of the industry. These main drivers are identified as:
- Sufficient plant available to meet not just the peak demand of the year but day by day, 1/2 hr-by-1/2 hr
- Maintain quality and supply in terms of frequency control, voltage control, and system stability
- Manage and operate the system so that customers do not lose their connection after a credible system loss, constraining plant as necessary
- Manage fault situations and, if severe, then restore the network as quickly as possible

The system operations structure operating in England and Wales is working well and the quality of supply has not been degraded, but it is important to recognize and learn from some of the operational issues and difficulties that have been encountered. Impact on operation and security can be explained in terms of the three different operational timescales: planning, programming, and control.

Planning Phase
- No longer is there any capacity planning for meeting future demand, nor is there any overall coordination of where generation is sited, to ensure overall power system economic efficiency.
- Power Stations only need to give 6 months notice of closure.
- The National Grid Company, plc. (NGC), as the Transmission Company, has very limited control over the new connections required.
- Offers of terms for connection must be dealt with within three months, identifying all the necessary system reinforcements.
- Even when signed, there is no guarantee of completion of the connecting party.

Programming Phase
- The lack of overall generation outage coordination requires transmission outage planning to be very flexible.
- There is an impact on construction work; it will not be canceled, but it may not now be the best overall time.
- These issues could lead to higher constraint costs due to more out-of-merit plant having to run.
- This in turn means that flexible transmission systems as well as flexible resourcing are required.

Control Phase
- There is a less guarantee of generation availability but still the quality and security requirements remain.
- Operation of the Pool is a major logistical exercise which requires an enormous data management system.
- There is a much greater commercial awareness now because of the importance of the Pool data to the individual companies.
- But, there are now also far greater commercial liabilities if the operators get it wrong.

Learning from Worldwide Experiences

The recent privatization and disaggregation of the electricity industry in the UK and, in particular, the creation of an Open Access Power Pool in England and Wales has resulted in major cultural changes that have led to:
- Greater business awareness at all levels of the industry
- Innovation, both technical and commercial
- Greater customer awareness
- Smaller companies with clearer focus and responsibilities
- The best interest of the customer has not been lost, quality has been maintained.

This is best demonstrated by looking at the effects of several major events since privatization:
- Successfully meeting the television peak load of 2,800 MW, when England lost to West Germany in the World Cup in July 1990
- Successfully managing the December 1990 severe blizzards and storms; there were some 900 trips in 40 hours
- Successfully restoring the system frequency within 2 minutes in September 1991, when the 2,000 MW link to France tripped.

Restructuring the electricity industry, separating generation from transmission, and creating a pool is not easy. It can be done, and successfully. Lessons need to be learned from others who have undergone such a change; and considering such issues beforehand, and taking account of them, can lead to a more sustainable solution that is right for the particular system in question.